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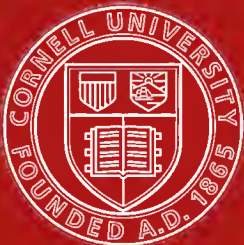
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PERMANENT
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PASTURES.

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PERMANENT AND TEMPORARY PASTURES

WITH DESCRIPTIONS AND COLOURED ILLUSTRATIONS OF LEADING

NATURAL GRASSES AND CLOVERS.

BY

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SUGGESTED BY AN ESSAY BY

MARTIN HOPE SUTTON

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TO
HIS ROYAL HIGHNESS
ALBERT EDWARD, PRINCE OF WALES,
DUKE OF CORNWALL, K.G. &c.

PRESIDENT OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND, 1885-6,

THIS WORK
IS RESPECTFULLY DEDICATED

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BY
HIS ROYAL HIGHNESS'S OBEDIENT SERVANT,

MARTIN J. SUTTON.

PREFACE

TO

THE FOURTH EDITION.



ALTHOUGH the third, or popular, edition of this work met an acknowledged want, there is a continued demand for the book in its original form, including the coloured plates. As the publishers do not possess a single copy of either the first or second edition, I have again revised the text, especially the first chapter in view of the increasing importance of dairy management.

Hints are added on the means of identifying various grasses when not in flower; and on page 102 will be found a tabular statement of results obtained from manuring experiments on a young pasture during five successive years.

Drawings on an enlarged scale of seeds of the grasses illustrated are, for the first time, included on pages 140 to 172.

I gladly embrace this opportunity of rendering sincere thanks for numerous friendly reviews of former editions, and also for kind suggestions which have been communicated to me by letter.

MARTIN J. SUTTON.

READING: *February* 1891.

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PERMANENT AND TEMPORARY PASTURES.



THE EXTENSION OF PASTURES.

THE 'Agricultural Returns for 1890,' issued by the Board of Agriculture, show that in England alone the 'total of land under all kinds of crops, bare fallow, and grass,' excluding nursery grounds and woods, is 25,008,147 acres. Of this area, 12,836,200 acres are in permanent grass, and 12,171,947 acres are under arable culture; whereas in 1870 the arable land exceeded the pastures by 4,049,000 acres.

In Great Britain the total cultivated area is returned as 32,768,335 acres, of which 16,017,492 acres are given as pasture, and 16,750,843 acres as arable—an increase of permanent grass between 1871 and 1890 inclusive¹ of 3,944,636 acres. During the whole period of twenty years the progress of the movement has been uninterrupted, the highest figure being attained in 1871 with 362,586 acres, and the lowest in 1885 with 51,658 acres.² The average addition per annum is 197,232 acres, and the following statement shows the advance in each year.³

¹ It must unfortunately be admitted that a proportion of this vast acreage has been allowed to 'go to grass' unaided, in consequence of the inability of owners or occupiers to cultivate the land.

² The increase for 1885 is understated; see pages 13 and 14 of *Agricultural Returns* for 1886.

³ Perhaps it is scarcely necessary to remark that the advance recorded in each year is the result of sowings made in the preceding season. As a rule, grass seeds are sown upon corn, and in the year of sowing the return is made under wheat, oats, or barley.

In 1871 . . .	362,586 acres	In 1881 . . .	216,438 acres
1872 . . .	140,164 "	1882 . . .	178,278 "
1873 . . .	340,323 "	1883 . . .	243,698 "
1874 . . .	262,083 "	1884 . . .	225,447 "
1875 . . .	134,609 "	1885 . . .	51,658 ¹ "
1876 . . .	203,323 "	1886 . . .	192,801 "
1877 . . .	212,411 "	1887 . . .	136,116 "
1878 . . .	182,941 "	1888 . . .	74,802 "
1879 . . .	255,428 "	1889 . . .	119,666 "
1880 . . .	260,235 "	1890 . . .	151,629 "

Clover, Sainfoin, and Grasses returned under rotation crops for Great Britain augment the totals of grass by 4,504,884 acres in 1870, and by 4,808,819 acres in 1890.

Concurrently with this enormous extension of permanent pastures and grass under rotation, there has been a decline in wheat of no less than 1,114,207 acres.

When the wet summers persistently followed each other, the opinion was freely expressed that farmers were suffering principally from the excessive rainfall, and that immediately hot summers returned those who had hastily laid down their land would be equally hasty in ploughing it up again. But in the South of England we have had hot seasons, accompanied with drought sufficient to turn pastures brown and to prevent the growth of much aftermath, yet no one thinks of ploughing the sod. On the contrary, it is considered fortunate that part of the land is not subject to the heavy outgoings for labour which render arable cultivation so unprofitable.

Many causes have combined to necessitate the conversion of arable land into meadow and pasture. Chief among these influences have been the low price of corn, the reduced capital of agriculturists, and the increased cost of labour, and these forces still prevail.

However reluctant we may be to accept the condition as permanent, the fact is indisputable that foreign wheat can at present be profitably delivered in this country at a lower price than it can be grown here. Formerly the sale of corn was regarded as

¹ The increase for 1885 is understated; see pages 13 and 14 of *Agricultural Returns* for 1886.

the means of setting farmers' finances straight for the year. Now the corn rotation is looked upon almost as a necessary evil.

The very diminished capital in the hands of many farmers renders it impossible for them to till their land efficiently, and I am persuaded that the only way of ensuring justice being done to their holdings is by laying down a considerable proportion of the land to grass.¹

Not the least of a farmer's anxieties is the grave difficulty as to labour. Formerly it was urged that work for the rural population ought to be found on the land. On their side the labourers have solved the problem by refusing to live and work in the country. Landowners and farmers have been privileged to educate the labourers' children, with the result that the latter remain long enough at school to acquire a distaste for agricultural life, and the pick of the boys and young men flock into towns, leaving the feeble, incapable, and infirm to work on the farms. So that, having paid an education rate, in addition to other heavy burdens, farmers find that the efficiency of labour is diminished, while the cost is seriously augmented. Few farmers would object to pay the increase in wages were it possible in return to obtain as good a day's work from the men as their fathers gave for less

¹ Although Colonial farmers have been eager purchasers of our stock and implements, they have not hitherto manifested any anxiety to adopt our agricultural system. There are portions, however, of Canada and the Eastern States of America which are rapidly passing into the conditions which prevail in England, and the accomplished Professor of Agriculture at the Guelph Agricultural College in Ontario created a considerable sensation by calling the attention of farmers in the Dominion to the necessity of following the English lead in the laying down of land to pasture. In a Lecture delivered by him, a copy of which he has been good enough to send me, are the following remarks:—'We are bound to produce cheaper and in greater quantity. It is not so much the area which is troubling, but the "per acre per annum," than which there is no truer gauge of national or individual wellbeing. Towards this end I respectfully submit that permanent pasture will have a great deal to say. As a stimulus to healthy appreciation of the importance of permanent pasture, and as one of the best possible ways to impress our people, I may ask why it is that Britain, with all her age, experience, and wealth of other things, has already placed half her arable under this crop. It is not altogether because of outside competition in other crops, nor of climatic trouble, but because she knows of no better way to conserve, to wait, and to make money by doing little at the least risk and outlay. Britain has never hesitated how to "hedge" in her agriculture when troubles arose, and to-day her farmers make more revenue per acre per annum on the best pasture than from any other source.'

money, but no such willing or efficient labour is now to be got.

Some political economists compare the laying down of land to grass with the action of Scotch landowners in amalgamating poor sheep-runs yielding little rent, and forming them into enormous deer-forests which bring handsome sporting rentals. They tell us that the creation of pastures is bad for the nation, not only because the land does not produce so much food when in grass as it does under the plough or under spade cultivation, but because there is less scope for the employment of labour on grass than on arable land.

Unfortunately, the question which agriculturists have to consider is neither the most productive method of cultivating land nor the system which will employ the largest number of labourers, but the most certain way of farming land at a profit. Surely landowners and farmers cannot be expected to till the soil at a ruinous loss unless the nation is prepared to pay for this supposed benefit out of the public purse. Until it is considered reasonable that men should beggar themselves for the national good, cultivators must be free to farm in the way that promises the best return for the capital and skill devoted to the business. I do not suggest that an extension of permanent or temporary pastures in every part of the country will confer the highest social and economic benefits upon England; but it will certainly save many farmers from conducting their business at a loss, by enabling them to manage their holdings with a reduced capital, and by cutting down a labour bill that is now too heavy for their income.

The successful farmer of the future will be the man who is quick to apprehend and prompt to supply the public requirements of the day, and who is willing to take advantage of every invention that will help to render him independent of the agricultural labourer. Enormous strides have already been made in this direction. Threshing-machines, steam-ploughs, and self-binders have revolutionised the conditions of agriculture. Indeed,

it must be patent that in the absence of such labour-saving machinery English husbandry could not be carried on by the present deteriorated body of farm labourers. And finality in labour-saving is no more attained in husbandry than it is in manufacturing industries. As yet the electrical engineer has rendered the farmer no assistance, but I am sanguine that in the near future discoveries in this direction will be made which will eclipse all that has previously been achieved in the interests of agriculture.

The laying down of land to grass appears to me to be quite as much a question for landowners as for tenants. The former have a direct interest in promoting the movement, as a means of avoiding the deterioration of their land, and of attracting tenants to their farms.¹

I freely admit that there are large tracts of land in this country which are unsuited for the economic formation of permanent pastures, because the finer grasses die out, and the soil gradually becomes filled with moss, twitch, and worthless indigenous grasses. Much of the prejudice existing against the making of pastures has been caused by fruitless attempts to coerce Nature. But, granting that the formation of permanent pastures cannot be universally advocated, there is no farm land with which I am acquainted that will not profitably respond to the alternate system alluded to in the chapter on 'Temporary Pastures.' The advantages of that system, however, are by no means restricted to soil which is unsuitable for permanent pastures. The practice of the Lancashire and Scotch farmers has abundantly proved that no other method of farming pays so well as laying down land in artificial grasses for periods varying from two to four years, instead of simply sowing clover and breaking it up after the first season. Temporary pastures are now recommended for general adoption by some of the most enlightened and able agriculturists of the country, and I look forward to the wide

¹ Farms which have a fair proportion of grass have been in constant demand, while it has in numerous instances been found impossible to obtain tenants for farms wholly arable.

extension of this system, not merely as a great means of lessening the labour bill, but also because it will ensure the storage in the soil of a large reserve of grain-producing energy ready for any national emergency, or in the event of such an alteration of public opinion concerning Free Trade as will enable the farmer again to produce the food of the country at a profit to himself. At present the only hope of obtaining such profit from much of our strong land is to grow grass permanently or in rotation, and turn it into meat or milk.¹ For milk alone there is an immense future when the populations of large towns better understand its value as an article of diet, and when the requisite arrangements are made to ensure its cheap and speedy delivery in freshness and purity direct to the masses of the people.

Much was anticipated from milk factories, and some of them are commercially successful, but it does not appear to me that for the majority of farmers the difficulty of distribution will be surmounted in this way. Milk is easily and quickly spoiled, and only a small proportion of its bulk is required as a manufactured commodity. On these grounds it is imperative that milk should be dealt with at the earliest possible moment after it has been obtained from the cow, and therefore in immediate contiguity to the milking shed. Hence the immense value of hand and power milk separators, of which I was one of the first in this country to avail myself. Notwithstanding the prejudice against their introduction displayed by farmer and farm-servant alike, I have not heard of a single instance where the separator has been abandoned after a fair trial. There is no waiting for the cream to rise, and consequently not the least suggestion of sourness. The tedious process of skimming is avoided, and instead of rows of pans to be constantly scalded, a few crocks only are required for the cream. The separated milk never reaches the dairy at all, but goes straight to the labourers' cottages, or to the calves and mash-tubs for pigs, in a perfectly sweet, wholesome, and digestible condition.

¹ An authority has called attention to the fact that, even at the current low price, a ton of milk is worth more than a ton of wheat, and costs less to produce.

Thus the whole of the milk, minus the fat, is retained for the benefit of the farmer and his labourers, whereas, when sent to a factory, the separated milk is lost. From repeated tests I have been able to assure myself that a separator will produce one-third more cream from a given quantity of milk than can be obtained in the ordinary way by skimming, so that the cost of the machine is quickly saved. And in the cream alone there is a portable and saleable commodity, when it is not required for butter-making.

Condensed milk may perhaps be profitably manufactured in this country, but it can scarcely be to the interest of the farmer to encourage an industry which will place him in competition with the whole world. He had better devote attention to the more delicate products of milk, which suffer from long transport.

The taste for fancy cheese has greatly developed in recent years, and there is no reason why English agriculturists should not compete successfully in the production of some of the more perishable kinds. The manufacture of marketable commodities, such as butter and soft cheese, will prove of especial service in districts that are too remote from populous centres to enable the milk trade to be carried on at all times with profit.

Beef and mutton can be more cheaply fattened, and milk more cheaply produced, on a farm of which one-half or two-thirds is in grass than on arable land alone. It may not be possible to fatten so many beasts or sheep per acre as when stall-fed on arable produce; but the point now under consideration is farming at a profit, and I believe that one of the most potent factors in the increase of pastures, and especially of temporary pastures, will be this facility of producing meat and milk with advantage to the grazier as well as to the consumer.

THE DRAINAGE OF GRASS LAND.

It is beyond the scope of this work to treat the subject of drainage exhaustively. But while giving a few practical hints on draining operations, I propose to refer to some of the laws which render it impossible to maintain a first-class pasture unless land is effectually drained either by natural or by artificial means.

An impression widely prevails that, however necessary effectual drainage may be for other farm crops, grass lands may with impunity be left undrained. This is only one part of the tradition of carelessness which past generations have handed down concerning pastures. No one who is accustomed to examine water-logged meadows can fail to be impressed by the worthless nature of the herbage they produce. If there were no cure, or the expense of the remedy were out of proportion to the benefit to be derived from it, apathy might be excusable. But as to the greater part of the undrained grass land which is now lying in a comparatively unprofitable condition through stagnant moisture, there is no doubt that the vegetation can be immensely improved in quality. Drainage of pastures has never been known to be other than beneficial; and in most instances the quantity of hay or feed will also be greatly augmented, although from some land already yielding a large bulk of herbage of a low quality the increase after draining may not be immediately apparent. The total bulk may even be temporarily diminished. But the loss will be confined to those plants which possess little or no feeding value, and therefore regret need not be expended on their disappearance. And, as a rule, the work can be carried out at a cost which will

be returned with interest in the course of a very few years. Drainage alone will go a long way towards turning a marsh into a profitable pasture, and it renders other improvements possible at a trifling expense. The important point to be urged here is that in future no undrained land shall be laid down to grass. Otherwise careful tillage, costly manures, and the finest grass seeds will certainly be wasted. The result is only a question of time. Sooner or later the valuable grasses which are sown will be supplanted by sedge and rush and other semi-aquatic vegetation, until the pasture gradually reaches the worthless condition which invariably prevails on undrained land.

Every year more water passes through land which is naturally or artificially drained than through soil which is generally saturated with moisture. Where stagnant water lies no rain can enter: it simply runs off the surface by any outlet it can find. The soil can neither breathe nor digest any fertiliser applied to it, and it is incapable of utilising the sun's heat for the development of plant-life.

When rain falls on a well-drained field it does more than merely moisten the soil and supply plants with water. It has been computed that in each year by means of rain alone every acre of well-drained land in this country is benefited to the extent of ten pounds of nitrogen. Indeed, one of the advantages of good drainage is that it allows the atmosphere to be freely carried into the soil by rain, when the oxygen sweetens and converts injurious organic substances into wholesome food for plants. At the same time, carbonic acid gas derived from rain and air performs the same operation for the mineral constituents of the soil.

Another advantage which results from draining is an increase in the temperature of the soil. It is well understood that evaporation produces cold, and the more rapid the evaporation the greater the cold. Travellers in the East will recall the delightful surprise experienced when first they drank the cool water from a porous jar while the thermometer registered over

100°. Here is an illustration of the conditions which prevail on a hot day with water-logged soil. Under scorching sunshine, the soil when full of water becomes intensely cold immediately beneath the surface. The top crust may feel warm to the touch, but a plunging thermometer forced into the subsoil will reveal a difference of many degrees in temperature which the rainfall on the surface is powerless to raise. Warm water is never known to descend naturally, and when the sun's rays cease to fall on undrained land the cold subsoil quickly brings the surface to its own low temperature. This rapid change gives birth to the mists which in autumn are so familiar in the Fens and in the valley of the Thames. Surely there need be no wonder that under these adverse conditions the grass on badly-drained land is late to begin growing in spring and early to cease in autumn.

An eminent German scientist has demonstrated that there is an intimate connection between a warm dry soil and economy in feeding cattle. Friable land absorbs more heat than land which is saturated with moisture, and retains the heat for a longer period. Upon the one animals lie warmer, especially at night, than they do upon the other. Now a large proportion of the food consumed by animals is utilised for the production of the heat which is constantly dissipated from their bodies. It follows that additional food becomes necessary to replace the animal heat lost by the colder surroundings.

Land which is properly drained comes under the influence of another operation of Nature, to the great advantage of the crops upon it. Water would, after it has passed through the surface to the subsoil, be lost to plant-life, were it not for the wonderful natural arrangement known as capillarity.¹ As the

¹ Baron Liebig, in his *Natural Laws of Husbandry*, thus describes the action of water in a state of motion:—

‘If we regard the porous earth as a system of capillary tubes, the condition which must render them best suited for the growth of plants is unquestionably this: that the narrow capillary spaces should be filled with water, the wide spaces with air, and that all of them should be accessible to the atmosphere. In a moist soil of the kind affording free access to atmospheric air, the absorbent root-fibres are in most intimate contact with

surface soil becomes freed from water, it draws up and re-absorbs moisture from below; and it is especially when the soil becomes dry, and its particles are disintegrated, that it possesses this power. The water which is thus brought from the subsoil contains some of the mineral constituents from the formation below which further aid the growth of plants. This fact accounts for the widely different grasses which are to be seen in old pastures on surface soils that appear to be identical. The mineral constituents in a state of solution are brought up by the water from considerable depths, and by this means, amongst others, the geological stratum asserts its influence upon the herbage growing on the surface.

It is a mistake to suppose that the rainfall goes direct to the drains and is at once expelled from the land. On the contrary, the rain sinks into the land until it meets and mixes with the subsoil water, and the drains do not begin to run until the subsoil water rises above their level. While water, however small the quantity, is flowing in a drain-pipe, and probably long after it has ceased to flow, it may be taken for granted that the subsoil is saturated with moisture up to the level of the drains. The rise and fall of the subsoil water are therefore determined by the level of the drain rather than by the surface of the soil, as it would be in an undrained state. Thus, in well-drained land, the atmosphere is being continually carried into the soil by rain, and forced into it by atmospheric pressure as the subsoil water falls to a lower level, and the air is expelled when the water rises. A water-logged surface is not only injurious to plant-life because there is too much moisture in it and too little warmth, but because neither rain nor atmospheric air can enter from above, nor mineral constituents be drawn from below. Drainage sets all these natural forces in motion, and they open the soil and disintegrate its particles for the benefit of the plant-life upon it.

the earthy particles; the outer surface of the root-fibres here may be supposed to form the one, the porous earthy particles the other wall of a capillary vessel, the connection between them being effected by an extremely fine layer of water.'

Again, drainage is always beneficial in promoting the early and late growth of grass, and this is of enormous value in feeding stock. The early autumn and late spring frosts do not arrest growth on drained land so quickly as on that which is sodden with moisture. And on the latter there is also the additional injury which the hoofs of cattle inflict on the grasses. Thus one of the effects of drainage is to produce an ever-growing crop.

It has been urged with perfect truth that from arable land manures are often washed into drains, especially in wet seasons, and that in draining, a farmer may be providing an outlet for manure which he has placed on the surface at great expense. Experiments by the late Dr. Voelcker and others have clearly proved that, with one exception for which the remedy is easily applied, the loss of fertilisers by means of the drains is inappreciable when a green crop is on the ground. On the contrary, water flowing from the drains under a bare fallow alongside, may at the same time be highly charged with manurial matter. Hence the grass farmer is protected from this particular loss as the arable farmer cannot always be. The exception above alluded to is the possible loss of lime. This essential constituent of plant-life is one of the substances most easily lost by the drains, and it accounts for the necessity of applying this mineral from time to time on drained land which happens to be deficient in it. But while ammonia—which becomes oxidised into nitric acid, and, entering into combination with lime, forms nitrate of lime—may possibly be wasted, it is satisfactory to remember that superphosphate of lime and other forms of phosphoric acid are never thus lost. Nor does it appear that potash is easily abstracted, so that there need be no hesitation in applying these substances from fear that they will be carried away by the drains.

It may be accepted as a general truth that grass land should not be drained so deeply as arable land. The weight of engines and heavy agricultural machinery has not to be allowed for, and there is no doubt that grass can advantageously absorb more moisture than corn crops. Further, the roots of most grasses do

not penetrate very deep, and therefore it is desirable to have the water somewhat nearer the surface than on the arable part of the farm.

As to the practical part of draining I need say but little. There are tracts of country without any arterial drainage, no river or stream being available into which drains, if laid, can discharge their effluent water. The remedy is of course beyond the power of private individuals except in a few rare instances. Such works can only be carried out by Government, or by companies with large funds and under parliamentary sanction. This subject will, however, one day, and I hope not remotely, claim more attention from statesmen. Scientific engineering has rendered the task possible; the real difficulty lies in its cost. Meanwhile, in such exceptional districts, pastures having no fall for drain-pipes may be considerably improved by a system of gutter-cutting on the surface. This practice would often be serviceable on land subject to floods. Water should not be allowed to lie on portions of a field after the main stream has retired sufficiently to enable this water to flow if only a channel were provided.

The manner in which drainage should be carried out in any particular case depends on soil, climate, and other considerations. These conditions must of course be taken into account, but they concern the details and not the principle of the work. The difference between the rainfall in the eastern and western counties,¹ or between the West of England and Ireland, will regulate the nearness of the lines of drains and the size of the pipes. But these differences do not touch the main question whether to drain or not to drain. Soils which rest upon a porous subsoil certainly do not need it. Other land may be retentive, and yet lie so high, or at such a steep inclination, that the water is

¹ The annual rainfall in the North of Scotland exceeds that of the South of England by ten inches; and in the West of Ireland it is larger than in Scotland. The case named by Professor Ansted in his *Physical Geography* is still more remarkable. He says: 'At Seathwaite the fall is 127 in., and a few miles off, at Bishop's Wearmouth in Durham, on the other side of the moors, it is only 17 in.'

discharged with sufficient rapidity without artificial aid. Indeed, draining may always be considered unnecessary where the best natural grasses grow luxuriantly. With these exceptions all clay lands, whether the clay is only in the subsoil or rises to the surface, and all peat lands, whether the peat has clay beneath it or not, and in fact all land which is habitually saturated with water, must be effectually drained before a pasture worth having can be established.

The prejudice which occasionally exists against the adoption of a system of drainage can generally be traced to some instance where the workmanship has been bad, or where no care has afterwards been taken to maintain the efficiency of the pipes. These ought not to be covered in until they have been proved to work satisfactorily, and as draining is usually put out to contract, this matter needs close personal attention.

It is a safe general rule not to make any single drain too long. Plenty of fall should be given, or the pipes may not work well after they have been laid some time. A good fall renders them to a considerable extent self-cleansing, and the small drains should not enter the large drains at right angles, but always obliquely, so that the water may retain the momentum received in its previous career. Then the occasional flushing after a sharp storm will prevent the pipes from becoming choked. For short distances near hedgerows or trees, the use of socket pipes securely jointed with cement—not clay—is to be strongly recommended. The slight additional expense may save a large subsequent outlay.

As to the depth at which the pipes should be inserted, and the distance between the rows, no definite rule can be laid down. Experience has proved that in heavy land they must be near together, and not too deep; but in lighter land the lines may be comparatively far apart. About three feet deep with the rows fifteen feet apart is the usual proportion, but almost every field has some peculiarity of conformation or subsoil which affects the question. After the pipes are covered in, one man should always

be held responsible for periodical examination of the outlets, to ensure their being kept in working order.

Sometimes there is an indurated pan, or hard mass, formed beneath the cultivated surface by the weight of the plough and the horses' feet through a long series of years. A similar condition resulting from natural causes is found on some heath lands, four or five inches below the surface. These hard subsoils are as impervious to water as beds of cement. Before putting drain-tiles into such land an experiment should be made to ascertain whether satisfactory drainage cannot be obtained by breaking up the subsoil to a sufficient depth. If the trial prove successful, the expense of putting in tiles may be saved, and the fertility of the land will be increased. But in many cases it will be necessary both to break up the subsoil and to put in pipes before effectual drainage can be secured.

CULTURAL PREPARATIONS.

OF all the questions which concern the laying down of land to grass, perhaps there is not one which has received less consideration than the condition of the soil at the time of sowing. Grass is frequently regarded as a last resource for land which is thoroughly exhausted, and which no longer pays for the cultivation of any other crop. It is too often assumed that grass will grow anywhere, and under all circumstances. And although the old and wasteful process of allowing land to go to grass is no longer advocated to any extent, many farmers consider it sufficient to harrow in a few seeds, and let them take their chance. The practice is extremely mischievous, resulting in immense loss both of time and money to those who follow it. The fact is that no farm crop requires more care in the preparation of the land than does a crop of permanent grasses; and there cannot be greater folly than to sow costly seeds, especially of the finer varieties, on land which has not been adequately prepared to receive them.

The choice of suitable land for permanent pasture is seldom open. Other circumstances than its fitness for this purpose generally determine the matter. But occasionally it does happen that on some estate or farm there is a possibility of selecting the fields which are to be turned into grass. The guiding principles are few and simple. It may be accepted as an established conclusion, that sharp sands and gravels are not well adapted to the formation of pastures, but that heavy loams and most strong clays are eminently suitable for grasses and clovers, and will

produce abundant crops. The fact that heavy soils are expensive to cultivate as arable is an additional reason why they should be laid down to grass. Again, if there be the choice of two fields, one sloping to the north and the other to the south, preference should be given to the former, because it will be less liable to burn in a hot summer.

Drainage is a matter of the utmost consequence, and this fact is enlarged upon in the preceding chapter. If the land is naturally well drained, there will be a fortunate saving of expense, but otherwise this operation should be preliminary to all else.

Beyond question, the very best preparation for a spring sowing of permanent grass seeds is a bare fallow in the previous summer. This affords the opportunity of destroying successive crops of indigenous annual weeds, and it is important that these should be got rid of by scarifying and dragging rather than by ploughing, for the plough is only too certain to bring to the surface a fresh stock of weed seeds ready to germinate in the following spring. Many influences may aid or hinder the work of preparation, which depends not only upon the character of the soil and the previous cropping, but also upon the atmospheric conditions which prevail while the operations are in progress. Here the advantage of a bare fallow is realised, because the cultivator has the whole summer and early autumn in which to accomplish the task.

Deep ploughing should be carried out first, and if subsoiling is considered necessary there is all the greater reason for doing it early. Then, by means of the scarifier and the roller, the soil can be cleaned and so far prepared to receive the seeds that in the following spring only one or two turns with the harrow will be necessary to perfect the seed-bed. There are good reasons for insisting on a thorough preparation of the land in the first instance. Careless and half-hearted work wastes both seed and labour, and the necessary operations have to be attempted a second time under great disadvantages. Causes entirely beyond human control may sometimes render it needful to re-sow, even

after the most earnest effort; but no one should lay himself open to the possibility of self-reproach for having contributed to partial failure by neglect. More of the failures in attempting to create pastures could, if all the facts were known, be traced directly to the unfavourable state of the soil, and to its previous cultivation, than is generally believed, and it is true wisdom, as well as sound economy, to wait a year, or even two years, rather than risk sowing upon soil which is foul or out of condition.

The bare fallow, however, will be the exception; as a rule it cannot be afforded. In the interests of the coming pasture, a root crop is the next best preparation, and unless the land is capable of growing a first-class crop of roots it will be incompetent to produce even a fair pasture. Now a root crop offers this advantage, that, while few are disposed to manure a bare fallow heavily, a thorough dressing of farm-yard dung will not be denied to the mangels or swedes. To young grasses it is a great gain when, instead of manuring at or soon after sowing, the land can be made rich and put into good heart in the preceding year. The tender and delicate roots of the rising grass plant may be seriously impaired by contact with crude raw manure; whereas they will readily assimilate a rich dressing which has had time to become mellow, or to be absorbed into the staple.

Supposing land to be prepared by feeding off a crop of turnips with sheep, it may happen that the turnips have to be supplemented with meadow hay. If so, it is important that the hay should be only such as has been cut very early, otherwise the ripe seeds of the least useful grasses will, as they pass the sheep undigested, in due time spring up and make the pasture foul. Such a grass as *Holcus lanatus* and other worthless varieties often find their way into a pasture in this manner.

Whether the roots are fed off during September or October by sheep eating hay or cake—and the use of cake is to be strongly commended—or whether the roots are carted off during

autumn, in either case the plough should be put into the ground the moment it is at liberty. This first ploughing must be deep and thorough, and should be quickly followed by another ploughing to lay the land up rough for the winter. In February, or as early as the land is workable, get the harrow and the roller upon it until the seed-bed is fine, firm, and level. A tenacious soil, which dries off lumpy, may involve the expenditure of much time and energy to put it into good order. The delay will prove tantalising, but impatience is a bad husbandman, and the implements must be kept going until a satisfactory finish is obtained. It should be more generally known that few grass seeds will grow at a greater depth than half an inch even in fine friable soil. In cracks and fissures they will be utterly lost. Hence a sowing on ground which is rough is foredoomed to partial or entire failure, and the plants which do come will be the coarser varieties only.

Consolidation is equally important, for the young grasses cannot obtain foothold upon a loose or hollow soil. In such a case it is impossible to secure a perfect plant; and here again the finer sorts will fail. It is no unusual thing to see a capital plant of grass all round the headlands of a newly-sown field, while the centre is thin or bare. The explanation is simply this: the greater traffic over the headlands created a firmer seed-bed for the grasses than was made for them elsewhere.

Even after the land has been fully prepared for the seeds, it will be all the better if allowed to lie untouched for a few days before sowing; but if the season is advanced waiting may be dangerous. Otherwise the delay offers two advantages. It allows the soil further time to settle down, and also gives the annual weeds a chance to start, so that by a final turn of the harrow they may be killed before the grass seeds are sown. Annual weeds, unfortunately, are sure to come only too plentifully, and will demand constant attention when grass seeds are sown without a corn crop in spring.

As a preparation for autumn sowing, no other crop is equal

to an early variety of Potato. The earthing up of the rows exposes a great surface to atmospheric influences, and this materially aids the disintegration of the soil. Another point in its favour is that the crop is generally lifted by hand, and thus the soil is subjected to a course of spade husbandry, which, as a preparation for grass, is superior to all other modes of cultivation. When digging the crop the benefit may be further augmented by instructing the labourers to fork up and throw aside every bit of couch they come across. This will very effectually assist the cleaning process. The only objection to sowing immediately after Potatoes is the difficulty of consolidating the land; but by planting a first early variety, such as Field Ashleaf or Early Regent, the crop can be marketed in July, and before the grass seeds are sown in August a persistent use of the harrow and roller will do much to make a firm seed-bed.

It will now be proper to refer to some of the emergencies which arise when land must be laid away to grass at the earliest possible moment, whether it is in a fit condition for the purpose or not. One of the commonest instances is that of a clover ley which it is desired to turn into a permanent pasture. There is a natural feeling of reluctance to break up the clover plant, and the hope is indulged that grass seeds will take upon it. The objections to this course are many and serious, although they are not always insurmountable. Possibly indigenous weeds have already such a hold of the ground as to afford very little chance of the grasses making head against them. But whether this be so or not, in soil crowded with clover roots the young grasses will have but scant opportunity of establishing themselves. Still, however undesirable the practice of turning a ley into a permanent pasture must ever remain, necessity knows no law, and sometimes this unpromising experiment is crowned with success. Those who leave much to chance will deserve and obtain a poor result; but the man who is persistent and determined to succeed will often secure a fair return for his labour and outlay. The chief inducement to make the attempt is the probable saving of a con-

siderable outlay in breaking up the land and getting it ready to sow down again.

The first process in converting an old ley should be a vigorous harrowing in the autumn, and it must be no child's play. There is not the least cause for alarm in the apparent wreck of the standing plant. The more ruthlessly it is torn the better chance will there be for the grass seeds, and the more satisfactory the ultimate pasture. Follow up with a top-dressing of cake-fed manure or compost early in the winter, and the land will then be, although only in a limited and imperfect manner, prepared to receive the grass seeds in the following spring. Of course the old clover plants afford very considerable shelter to the newly-sown grasses.

So little remains to be said on this part of the subject that perhaps it will be convenient to dispose of it at once, although the question of seeding does not properly belong to this chapter. As to the choice of seeds, it is mere waste to sow fine or weak-growing varieties on an old clover ley. The adverse circumstances of the case will afford them little chance of struggling into life, to say nothing of a profitable existence. The sorts selected must be the stronger and more robust of the perennial grasses, and the seed should be got in early, before the clover has time to shoot vigorously in spring. Accomplish the task in February if possible; bush-harrow after sowing, and as a finish put the roller twice over every part of the field.

A different but very frequent case of emergency is that of a piece of glebe or other land that has been neglected for many years until it has become a perfect mat of couch or black twitch (*Alopecurus agrestis*). In despair of cleaning it at a reasonable cost, the rector or owner decides to allow it to 'go to grass,' as hundreds of acres have actually gone. Wisely it is considered desirable to give Nature some assistance, but it is almost a misnomer to dignify that assistance by the name of preparation. In this instance also the routine previously advised is applicable. Rigorous harrowing in autumn, a heavy top-dressing during

winter, and the sowing of suitable strong-growing seeds in early spring, are the means by which the most profitable results can be ensured. I know plenty of cases where this rough-and-ready treatment has been followed by a fairly paying plant. Especially may improving crops be anticipated when the land is continuously manured, or where grazing cattle are liberally assisted with artificial food.

I have tried the experiment of feeding a second crop of clover with sheep eating cake, and sown grass seeds in front for the sheep to tread in as they fed the crop. This was attended with most remarkable success.

Other instances of a similar character might be cited, but as they only need some modification of the method already explained, it may be enough to say that I have known tolerably successful pastures to be formed on an old Sainfoin ley, a worn-out Lucerne plant, a three or four years' ley, and even on clean Barley and Oat stubbles, without ploughing or using any other implement than the harrow, the seed-barrow, and the roller.

THE SELECTION OF GRASSES AND CLOVERS.

ALL the operations which concern the making of a pasture are important, but it is no exaggeration to say that a judicious combination of the various grasses and clovers which are to constitute the crop may be justly regarded as vital to success. Failure here means the waste of all other energies, for it is worse than useless to incur the labour and expense of establishing plants which are not wanted. However good they may be elsewhere, they will be no better than weeds if they fail to answer the required purpose. The choice of suitable seeds has provoked greater conflict of opinion, both among theorists and practical men, than aught else, and in my opinion the main cause of the controversy arises from the attempt to deduce large inferences from small experience. The laying down of land to grass is only an occasional incident on most farms—perhaps it would be correct to say on most estates—and in years not far removed it was less frequent than at present. Even now it is the exception to find persons who are able to speak from experience gained from actual practice over more than a very limited area. Yet the man who has dabbled a little in laying down land will sometimes follow it up with a letter to a daily or weekly newspaper, or deliver a speech at a local farmers' club, from which it might be inferred that the agriculturists of the United Kingdom will find in a particular mixture of seeds the preventive of all the ills that grass lands are heir to. Now a little knowledge on this subject is a very dangerous thing. No prescription, however excellent every

one of the varieties which compose it may be, can by any possibility be suitable for universal application. The attempt to put forward even a first-class mixture of grasses for all soils and all purposes savours essentially of empiricism. The dogmatism which proclaims the 'universal mixture' of grasses is near akin to the pretensions of the quack medicine vendor that his particular nostrum will infallibly cure all the complicated evils under which humanity suffers. Those who possess the widest experience on this subject are least inclined to lay down rigid rules. Land agents who have had the management of large estates in various parts of the country, and who have had greater opportunities for extensive observation than most men, are exceedingly careful to consider differences of soil, subsoil, and the purpose to which each individual pasture is to be devoted; and their success is chiefly attributable to the wise application of general knowledge to special cases.

It is interesting to pursue the various phases of the question as they are exemplified in the current public journals. A fashion comes into vogue for a time, to be superseded and condemned by the fashion which follows. Some pet theory is driven hard, and takes the public fancy. It is declared to be infallible; that wisdom will die with its author; and that all preceding writers were mere presumptuous novices. The past fifty years furnish many amusing instances of this kind. Some time ago a cry was raised that Italian Rye Grass was the saving clause in British agriculture. It was not only to be grown alone and in alternate leys, but no permanent pasture could possibly be successful which did not contain a large proportion of it. When this theory exploded there was a rebound to the other extreme. Italian Rye Grass was said to be generally unfit for a permanent pasture, and in this opinion I concur, although I do not agree with those who allege that Italian Rye Grass deteriorates into twitch, and is therefore unsuitable for cultivation. Italian Rye Grass never yet produced twitch, although it is quite possible that the seeds of that pest may have been sown with an impure sample of it.

The misuse of Cocksfoot may be cited as another example. Instead of being reserved for those soils and purposes for which it possesses an undoubted value, it has been recommended for the production of high-class hay everywhere, and even for sowing on geological formations for which it is totally unsuited. I have seen pastures literally ruined by the introduction of Cocksfoot. Alternate leys on the Chiltern Hills, where Rye Grass and Clover had previously answered well, have, by the introduction of Cocksfoot, yielded almost unsaleable hay, and, having once been allowed to seed, the Cocksfoot has proved a pest difficult to eradicate. Those who are familiar with the art of forestry are well aware that it would be futile to attempt to grow elm timber on sandy land, or larch on land which is only fit for Scotch fir. And if an opinion were promulgated that any single kind of timber should be grown upon every estate in the kingdom, it would excite general ridicule. Had the laying down of grass received the careful attention which has been devoted to forestry, it would be considered just as unreasonable to sow Cocksfoot on all soils and for all purposes, as to recommend elm trees to be planted everywhere.

The sowing of Poas has been condemned as unnecessary because it happened that some varieties of this grass were indigenous where the experiment was made. But a New England farmer will not hesitate to sow *Poa pratensis* alone, and long experience has proved that he does not prize this grass too highly. On the other hand, in certain districts of New Zealand, where *Poa pratensis* develops into a twitch of the worst character, the suggestion that it should be sown at all would only provoke an expression of incredulous amazement. Surely such a widely different estimate of the value of a single variety may well suggest a doubt as to the universal adaptation of any one kind of grass to all soils and districts. Indeed, the whole question is one of experience, and I am well persuaded that those who possess the largest knowledge, obtained from the widest sources, will concur in the opinion that each individual case

should be considered independently and upon its own merits. I would lay great stress upon the necessity of starting with a clear understanding of the condition and capabilities of the soil. The subsoil, too, must be taken into account, for sooner or later its influence will tell decisively upon the existence of certain grasses. Then the purpose of the crop must not be overlooked. Whether it is chiefly for hay, or entirely for grazing, will prove an important consideration in determining the sorts to be sown. Even the kind of cattle the land is intended to carry is worth more than a passing thought. Milch cows, fattening stock, sheep and horses, or a combination of these animals, can be provided for if proper care be taken in the selection of grasses and clovers.

I propose to describe the various plants, seeds of which are generally sown for permanent pastures and alternate husbandry, stating their relative value and fitness for certain purposes, together with such other particulars as will indicate the sorts and proportions to be used on the different soils and under the conditions usually prevailing in this country. I can scarcely hope to render it a very easy matter to make the selection in any case; the subject is much too complex for that. But I am anxious, as far as may lie in my power, to prevent a repetition of the costly blunders which have too often been made in this branch of British agriculture.

AGRICULTURAL GRASSES

(GRAMINACEÆ).

AGROSTIS ALBA—VAR. STOLONIFERA

(*Fiorin*, or *Creeping Bent Grass*).

THIS plant thrives in spongy soil which is not firm enough to produce better herbage, and in land which cannot be drained it will get a living where other grasses perish. In mountainous countries where rain falls frequently and abundantly, and the atmosphere is moist, it grows freely, as well as in light land and on peat. It affords very early feed in spring, but its power of yielding late keep in autumn is its greatest recommendation. Fiorin has been pastured as late as the middle of December, but if not eaten down in autumn the herbage in the following spring is sweet and wholesome food for young stock. Not much more can be said in its favour. Cattle refuse it if they can get anything better, and in wet seasons its creeping roots become very exhausting to the soil. Another disadvantage is the tendency of the plant to become ergoted.

Although this grass has the peculiarity of rooting from the procumbent nodes of the stem, especially in pastures much trodden by cattle, it is not dependent alone upon the surface soil for support. In suitable situations the roots penetrate four or five feet into the subsoil, and to some extent these roots maintain the plant during protracted drought. A series of rainy summers always creates a demand for it out of proportion to its value, but when hot dry years return it is quite as unreasonably condemned.

The *Agrostis* family is generally deficient in nutritive value, and although this variety is regarded as an exception, and has indeed been highly recommended by several authorities, I do not concur in the opinion that it should be included in ordinary prescriptions, if only for the reason that the true variety is not always to be depended on from a sowing of seed. The method of securing Fiorin by obtaining plants from land where it grows indigenously, cutting up the long trailing roots, and planting them in prepared ground, is far too costly a process in proportion to the value of the grass.

A. vulgaris, *A. dispar*, *A. capillaris*, *A. alba*, and *A. nigra*, all produce seed so nearly identical in appearance with the seed of true *Agrostis alba-stolonifera*, that no botanist can detect adulteration, and as the last-named variety does not flower freely, the inducements to send a mixed sample to England are almost irresistible to the German and American collectors.

In the absence of the flowering panicle, *Agrostis alba-stolonifera* is easily recognised at all seasons of the year by the short leafy branches which burst through the sheath at each node of the numerous stolons. The ligule is rounded at the tip, and is as long as it is broad.

The botanical description and chemical analysis are given on page 140, facing an illustration.

ALOPECURUS PRATENSIS

(*Meadow Foxtail*).

Of the many species of *Alopecurus* this is the only one which is used for agricultural purposes, and it is justly regarded as one of the most important grasses we possess. The great partiality which cattle manifest for it and chemical tests alike reveal its high nutritive qualities. Although thoroughly perennial in character, it does not attain to full development until three or four years after sowing, and is therefore only adapted for alternate husbandry when the ley is to remain down at least three or four years.

Even then Cocksfoot is more suitable for temporary pastures, notwithstanding the fact that Foxtail is the more nutritious variety. Foxtail is, in fact, essentially a landlord's grass, for which he may willingly pay in the full assurance that the future of the pasture will justify the outlay.

Foxtail begins to bloom about the middle of April, but by the third week of May it is practically in full flower, and should there be a sufficient proportion of it in a meadow to warrant early mowing, the crop ought to be cut; for although ripening does not, as with nearly all other grasses, seriously deteriorate the quality, it is wasteful to allow the bulk of its palatable and nourishing herbage to be shrivelled up and lost on the ground while other varieties are maturing. The necessity for early cutting should influence the proportion of Foxtail included in a prescription for a meadow, but in laying down a pasture this consideration need not be entertained. After taking a crop it is one of the quickest grasses to commence growing, shooting up its green herbage before other varieties make a start, and in quantity the aftermath frequently exceeds the early growth.

One characteristic which alone gives Foxtail a high value is the immense quantity of leafy herbage it produces in proportion to the quantity of stalk, and for this reason the extent of its presence in a pasture often remains unsuspected. The early growth is also in its favour. Other conditions being equal, a pasture which contains Foxtail in abundance will carry stock ten days in advance of a pasture in which it is wanting. These facts have doubtless originated the idea that Foxtail is peculiarly a pasture grass, but it yields so good a crop and of such excellent quality that it is almost of equal service for making into hay. As one of the few grasses that thrive under trees, it should be plentifully used in sowing down orchards and shady pastures.

In the North this grass is not much sown for hay, because in high latitudes the culms seed long before other herbage is fit for the scythe. Otherwise it is as well adapted to Scotland as to the North of Europe generally, for there is scarcely a forage plant

known which endures cold so well as Foxtail, and spring frosts do it little harm. Even in the severest winters, when other grasses suffer much damage, Foxtail remains comparatively uninjured. Its distribution over this country is very unequal. In Devonshire it is uncommon, and in South Wales rarely seen. In districts where it is entirely wanting I should scruple to recommend the sowing of any quantity in new pastures; but the great excellence of the grass renders a trial on a limited scale desirable.

Sometimes Foxtail is carelessly mistaken for Timothy, but, besides other differences, the former comes to maturity quite a month before the latter. Both rejoice in strong soils, and a stiff loam or clay is necessary to fully bring out the fine qualities of Foxtail, and to maintain it in a green state during hot dry weather. Still, it luxuriates in warmth, and on well-drained land in moisture also, but during prolonged rain a heavy crop may be beaten down, and then it is liable to rot at the roots. This fact again points to the necessity of mowing in good time. *Alopecurus pratensis* cannot endure a water-logged soil, and it is useless to sow seed on undrained land. Yet it is one of the best grasses known for land under irrigation, and the water meadows in the South of England, which are largely formed of this grass, produce immense crops.

On very dry soils Foxtail is so stunted and diminutive as to appear to be almost a different variety, but even under such conditions it may sometimes be worth using in small proportion, and wet seasons will prove that this is not a mistaken policy. In parks and paddocks round residences where a green appearance and constant growth are important, it should be sown freely. The result will be grateful both to the eye of the proprietor and to the taste of the Alderneys or Kerries which graze upon the pasture.

True seed of *Alopecurus pratensis* is generally expensive, and it is so light and delicate in formation as to need exceedingly well-prepared land to ensure vegetation. Unfortunately the stiff soils which specially suit Foxtail are the most difficult to make

fine in time for sowing. But for this grass alone it is worth a strenuous effort to get the land into good order.

The short, degenerated, truncate ligule, and the long, broad, prominently veined leaves, together with the involute character of the emerging leaf, distinguish this species in the absence of its flowering spike.

The experiments at Rothamstead and Kidmore prove that nitrate of soda and mineral salts have a marvellous effect upon the growth of Foxtail. It assimilates larger quantities of manure than many other grasses, and differs from Cocksfoot in the fact that the latter appears to benefit more from ammonia salts than from nitrate of soda, whereas Foxtail does equally well with both.

Most of the seed imported into England comes from Southern Russia. The German seed sold at Breslau is immature and grows badly. Occasionally very fine samples are obtained from Sweden, but the best seed of all is Dutch; and although the most careful botanist can detect no difference between the seed grown in Holland and that obtained from other countries, the Dutch seed produces a much more robust as well as an earlier plant.

The botanical description and chemical analysis are given on page 142, facing an illustration.

AMMOPHILA ARUNDINACEA

(*Sea Reed, or Mat Grass*).

An Act passed in the reign of Elizabeth, and renewed in the reign of George II., prohibited the pulling up or otherwise destroying of this plant. Like *Elymus arenarius* it is used for fixing sand on the sea-coast, but it possesses no feeding value, and is rejected by all herbivorous animals. The name of Mat Grass arises from its being employed as a material for mats. It also makes excellent thatch. The time of flowering is July.

ANTHOXANTHUM ODORATUM

(Sweet-scented Vernal).

This very distinct species is grown chiefly for the pleasant odour it imparts to the hay crop, which enhances the price of the hay, and it is only when the grass is dry that the fragrance is fully distinguishable. So marked is this quality that in the South of Europe an extract is obtained from the plant which is used in the manufacture of scent. But the grass possesses an agricultural value quite apart from the purpose it serves as a condiment for cattle, for it is one of the earliest varieties, coming into full flower at the beginning of May. It is a true perennial, exceedingly hardy, and continues growing until late in autumn, so that the aftermath is actually much larger in bulk, as well as more nutritious, than the first crop. This fact clearly indicates that Sweet Vernal is as useful for grazing as for cutting. One characteristic of this grass is its brilliant green colour; hence it should be employed in mixtures for parks and ornamental grounds in larger proportion than would be reasonable if the quantity of hay or grass were of primary consideration. But its use in lawns is, in my opinion, a mistake, although it has been recommended for that purpose. The leaves are too broad and flat, and look unsightly in a sward that is kept down close; while for the park, especially round a mountain home, it is an invaluable grass.

Sweet Vernal grows abundantly in some parts of Devon¹ and in the Eastern Counties, and the plants invariably thrive better in pastures among other varieties than when two of them happen

¹ A gentleman in South Devon has written me concerning *Anthoxanthum odoratum* as follows:—

‘This grass grows wild in this neighbourhood in the hedgerows, and cattle are fond of it in the winter months. It has the merit of shooting very early in the spring. Towards the end of February we had a few days of mild and moist weather, and it commenced to sprout strongly, and I observed that all kinds of cattle preferred it to other grasses.’

to be contiguous. It is well adapted for deep, rich, moist soils, where it grows luxuriantly, and on marshy places it throws up flower culms all through the summer. In wet, peaty land it comes so large and reed-like as to deceive any but an experienced botanist. It also thrives under the shade of trees, and accommodates itself remarkably to irrigation. Yet, strange to say, this grass is equally at home on thin moors and exposed sandy dunes, and further experiments should be made with it on reclaimed land and sandy wastes near the sea, for it will live in soil which will not feed any other grass, and isolated plants flourish where only rushes and heather have existed before. It is also believed to have the property of discouraging the growth of moss.

This grass is easily recognised when out of flower by its sweet-smelling, short, broad leaves, as well as by the fringe of long hairs which surround the neat, obtuse ligule. The leaves, too, are somewhat hairy on both upper and lower surfaces.

The agreeable perfume imparted to hay by Sweet Vernal has created a demand for seed out of all proportion to the supply. It is gathered by hand from plants growing wild in the woods and clearings of Central Germany, and only a very small quantity is sent to this country. The result is the frequent substitution of the annual species *A. Puelii*, of which a large quantity is every year exported from Hamburg under the name of Sweet-scented Vernal. This grass (*A. Puelii*) cannot be made partially permanent even by the process of cutting, for it flowers all the summer long, and if prevented from seeding at hay time, the flower-heads are thrown up later, and, as cattle do not relish them, seed is produced and the plant dies. It is, therefore, extremely important to secure the true perennial *Anthoxanthum odoratum*, which is, and always must be, a costly seed.

Although manure does not directly injure this grass, it indirectly effects its ruin by enabling other varieties to elbow it out of existence.

The botanical description and chemical analysis are given on page 144, facing an illustration.

AVENA FLAVESCENS

(*Yellow Oat Grass*).

This grass produces forage of good quality, which is greedily taken by cattle. It prospers in marl and calcareous soil, and in all light land rich in humus, particularly in that which contains lime.

Avena flavescens does not flower until midsummer. In the Thames valley it contributes no inconsiderable portion of the herbage of the water meadows, and over the South of England it affords a fair quantity for the scythe at hay time, while the aftermath is abundant. The leaves are pale green ; flowers' golden yellow, and they show conspicuously.

In the absence of the flower the plentiful supply of soft deflexed hairs upon the lower sheaths, together with the ciliated ligule, are characteristics by which this grass may be recognised.

Until recently it has been difficult to obtain sufficient seed of *Avena flavescens*, and it is always exceedingly dear. Probably many of the adverse opinions expressed concerning this grass have resulted from sowing in its stead that pestilent weed *Aira flexuosa*, the seed of which is not altogether dissimilar from, but has often been sold for, *Avena flavescens* by those who are not familiar with the true article. Seed of the latter, however carefully saved, only germinates moderately well, and the high price necessitates its sparing use when arranging the prescription for a pasture. A full seeding of other grasses must be given, and then, if expense be no object, a pound or two of *Avena flavescens* may be added as a luxury.

Both at Rothamstead and Kidmore this grass has shown itself capable of holding its own very fairly without any manure at all. Nitrate of soda and mineral manures, however, considerably augment the produce.

The botanical description and chemical analysis are given on page 146, facing an illustration.

AVENA ELATIOR

(*Holcus avenaceus* ; *Arrhenatherum avenaceum*).

Tall Oat Grass is known by all these names ; and in Dauphiné, where it is very much grown, especially for seed, it is called *Fromental*. Sinclair recommended this grass for agricultural purposes ; but, notwithstanding his favourable opinion, it has not, in this country, received the attention it merits. At one time, no doubt, its value was overestimated, and, in the reaction which naturally followed, the grass was consigned to undeserved neglect. Possibly its somewhat bitter taste, and the aversion which cattle at first display towards it when grown alone, may account for the indifference shown to it in England, although when mingled with other grasses the objectionable flavour is not perceived. On the Continent, and especially in Sweden, it is largely cultivated, and both cattle and sheep take it freely. Its value for cold northern countries is indisputable, but a warm climate is necessary to fully develop its great merits. In the Southern States of North America it is regarded as one of the very finest grasses for producing an immense weight of herbage, far surpassing Timothy in the abundance of its crop. The roots penetrate so deeply into the soil as to enable the plant to withstand both cold and drought.

Tall Oat Grass is almost indifferent to circumstances, and may be grown pretty nearly everywhere. It is seen to least advantage on poor thin land ; but on all good light and medium soils, as well as in all forms of clay if not too damp, it grows from two to four feet in height. In warm forcing situations it will produce two heavy crops of hay in one season, and will continue to throw a blade until autumn frosts appear.

The plant starts into growth very early in spring, and after the crop has been mown there is one peculiarity which must be borne in mind, or much waste may result. When cut this grass absorbs moisture in the same manner as *Trifolium*

incarnatum, and therefore hay containing it must be got into rick as rapidly as possible. As it happens that the stems are not succulent, *Avena elatior* is one of the grasses which can quickly be made into hay, and the hay keeps particularly well.

This grass cannot be called strictly perennial everywhere, but it is fully twice as long-lived as Italian Rye Grass, and grows much herbage in its first year. In the second and subsequent years of its existence it is far superior to Italian Rye Grass. For permanent pastures it cannot always be regarded as suitable, on account of its uncertain duration, as well as because of its coarseness.

The long, smooth, narrow, deep green leaves, the youngest of which are tightly twisted or rolled throughout their length, together with the truncate ligule, will help to determine this species when the flowering panicle is absent.

The rapid growth of *Avena elatior* makes the plant a gross feeder, and it will absorb any reasonable quantity of manure, especially of the nitrogenous class.

For a three years' ley one-fifth of the entire sowing would not be an unreasonable quantity on a good deep soil, but its high price makes it necessary to be content with a smaller seeding.

When sown in autumn a much larger produce is obtained in the following year than from a spring sowing.

This grass is often erroneously confounded with *Avena bulbosa*—a perfectly distinct and worthless weed which is too well known in arable land. The *Avena fatua*, or Wild Oat, it does not even resemble.

BROMUS INERMIS

(*Awnless Brome Grass, or Hungarian Forage Grass*).

This grass is much used in the South-east of Europe, and grows an extraordinary amount of fodder. Trials made in this country prove it to be of great value to English agriculturists.

All kinds of stock eat it greedily, and take it even in preference to Italian Rye Grass. Compared with that grass, *Bromus inermis* starts earlier in spring, yields quite double the crop at the first cut, and the analysis made for me by Dr. J. Augustus Voelcker shows the *Bromus* to be the richer in albuminoids and nitrogen.

BROMUS SCHRÆDERI

(*Schræder's Brome Grass*).

This grass is not strictly perennial, and there is a prejudice against it because of the harshness of its foliage; still it is a valuable forage plant. From the sweetness of its taste and the readiness with which it is eaten by stock, there can be little doubt that it is highly nutritious. It is one of the earliest grasses to start in a temporary pasture, and I strongly urge a more extended trial of it in mixtures for two or three years' leys which are mainly to be fed off. In warm moist seasons especially its usefulness will be manifested. Several years ago I saw a field of this grass which kept an extraordinary head of sheep which were penned on it. The crop was ready at one end of the field as soon as the sheep had finished at the other.

The roots feed on the surface, and the plant will thrive on the thinnest soil. So vigorous is the growth that weeds are crowded out, and in my opinion *Bromus Schræderi* has not been cultivated in England to the extent it deserves.

CYNOSURUS CRISTATUS

(*Crested Dogtail*).

One of the chief sheep grasses of British agriculture. Combined with Hard Fescue and Sheep's Fescue it may be said to compose the best of our sheep pastures. It constitutes a valuable bottom grass, and is supposed to exercise a beneficial influence on sheep in the prevention of foot-rot. Certain it is that sheep show

great partiality for the leaves, eating them down so close that there would be a danger of the plant being exterminated were it not for the fact that the seed-culms soon become hard, and are then rejected by the animals, with the result that seed is matured and shed copiously almost every season. Superficial observers have occasionally misnamed these stalks 'bents,' and have depreciated the grass accordingly. Up to the time of forming seed, these stalks do no harm, but the actual production of seed interferes greatly with the aftermath. To prevent this injury, and because it is needless to allow seed to be shed every year, it is sometimes worth while to put the mower over the pasture in the early part of July to take off the rising culms. The stalks have been used as fine straw in bonnet-making.

At the time the crop is cut this grass is too small to make much difference in the weight of hay, and the fact has been urged as an objection to the sowing of Dogstail. The answer is that it is distinctly a grazier's grass, being found in all the most celebrated natural sheep pastures of the country; and its value for grazing is shown by its extraordinary growth in August, when other grasses are giving up.

On lawns and pleasure-grounds the fine evergreen herbage is especially prized; and in deer parks Dogstail should be liberally used, for deer are, if possible, more fond of it than sheep.

Cynosurus thrives in compact soil, and it will endure conditions under which few other grasses can exist. The roots are hard, and as they penetrate deep the plant is naturally adapted for dry soils, and can withstand drought. Still I have seen it growing luxuriantly on tenacious clays, especially near the sea, and it is singular that a grass which does so well on very strong soils should also find a congenial home on thin upland pastures. On dry loams with a chalk subsoil it should be sown freely. In fact, there is hardly any soil in the kingdom for which it is unsuited. Full maturity is not reached until the second or third year.

The following description of the foliage of this grass will aid

in determining its presence in pastures. Lower sheaths yellowish white; leaves tapering from base to tip; young leaves folded on the mid-rib; ligule truncate.

At Rothamstead and Kidmore this grass appeared to thrive equally on the unmanured plots and on the plots dressed with mineral manures alone. The plant manifested antipathy for ammonia salts, and an appreciation of nitrate of soda.

The botanical description and chemical analysis are given on page 148, facing an illustration.

DACTYLIS GLOMERATA

(*Rough Cocksfoot*).

This is one of the most widely distributed of all the grasses. It is indigenous in hedgerows and ditches in almost all parts of England, and shows considerable variations in character in different soils and situations; but prior to its introduction from the States in the eighteenth century, Cocksfoot does not appear to have been sown for agricultural purposes. On dry calcareous land the plant is stunted and wiry, while in fertile valleys and rich land it grows to an immense size. Its proper place is on good, strong, damp soils in low-lying districts, where it produces a great quantity of leafy herbage. In such land the culms do not change so quickly to woody fibre as on a drier soil, and the stalks are eaten down by stock with greater relish. Even on the land which best suits this grass, I would sow less of it than is generally advised, and use larger proportions of Meadow Fescue, Tall Fescue, and Foxtail instead. For Cocksfoot is an unsightly grass, growing in great tufts; the foliage is harsh to the touch, and the coarse hard stems, two or three feet high, are not only objectionable to the eye, but they prevent the hay from fetching top market price, and the flower-heads are extremely liable to ergot. Besides, the aftermath of Cocksfoot is inferior in quality to that of Foxtail, and on thin soils, in a dry season, the former is liable to be very much withered by rust.

It has been computed that an acre of Cocksfoot will sustain twice as many sheep as an acre of Timothy. This may be true of the early growth, but it certainly does not hold good of the later crop, for the productiveness of the two grasses is pretty nearly reversed after midsummer.

Recently a writer has given Cocksfoot greater prominence than older authorities assigned to it. As a result old pastures have unfortunately been ruined by a sowing of Cocksfoot, and new pastures have had to be broken up because this grass was sown in too great proportion. Concerning its immense cropping power on strong moist soils there cannot be two opinions; but it does not endure long-continued drought so well as Foxtail, and is entirely out of place in upland meadows. When a fine hay crop is the chief desideratum, Cocksfoot should be omitted altogether, and its place be filled by Meadow Fescue.

The relative position which Dr. J. Augustus Voelcker assigns to the feeding value of Cocksfoot is given in his report at page 138.

The valuable qualities of Cocksfoot are even better realised in a three or four years' ley than in a permanent pasture.¹ With Rye Grass and Clover it forms a superior feeding ley, and yields a very bulky crop for consumption on the farm, where its coarseness is not objectionable. Full inaturity is not attained until the second year.

Cocksfoot comes into flower in June, and meadows in which it abounds must be cut early so that the flowering culms may be in a young stage of growth. After cutting, the plant quickly starts again, and while tender the herbage is much relished by all kinds of cattle. Mere size or coarseness is not a standard of excellence, for a smaller crop of Cocksfoot from a rich, light

¹ The Swiss authority, Dr. F. G. Stebler, is very emphatic on this point. He says: 'It is chiefly in temporary meadows that it is most advantageous. Yet if sown too largely at first it has the same fault as if sown alone, forming cushions, and consequently an unequal turf. It is better to begin by sowing but little, and, after allowing other sorts to develop properly, to sow a little more later. Only in exceptional cases is it necessary to sow more than 15 per cent. at first. A good rolling is very beneficial in spring. This levels the tufts.'

loam has been proved by analysis to be more than equivalent to a heavier crop taken from fen land, and the quality is always higher before flowering than after the seed has been developed. Experiments show that in April ten per cent. of the herbage of this grass consisted of nutritive matter; while at midsummer the proportion was only about three and one-third per cent. These are important facts to be borne in mind in laying down a new pasture. To make Cocksfoot into hay at the end of April, however, would necessitate the sowing of this grass alone, because other varieties are not ready for cutting at that time; and Cocksfoot manifests such a strong tendency to grow in clumps, that, with no other grass to fill up the interstices, there would be almost as many gaps as plants.

The great size of Cocksfoot points to its usefulness in covers, although unfortunately it does not answer well with brushwood. Yet it thrives under trees, as is implied by its American name of 'Orchard Grass.' On pastures which are much shaded, a considerable proportion should be sown in company with Foxtail, Various-leaved Fescue, and other grasses which are reliable under dripping foliage.

Upon an understocked pasture Cocksfoot will send up its flowering stems, and I strongly advocate running the mower over in time to prevent seeding.

The thick, yellow base of the shoot, compressed above, and the strongly keeled leaf, with its erose ligule, will distinguish this species at all seasons of the year, in the absence of the flowering head.

Cocksfoot when stimulated with ammoniacal manures has a remarkable tendency to smother and starve out the clover plants of a pasture in which it abounds.

The botanical description and chemical analysis are given on page 150, facing an illustration.

ELYMUS ARENARIUS

(Sand or Upright Sea Lyme Grass).

No other grass is equal to this for binding loose or blowing sand, for which purpose its mat-like roots are naturally adapted. It has been extensively sown on portions of the English and Dutch coasts. Height, four feet. Flowers in July.

FESTUCA PRATENSIS, *Hudson**(Meadow Fescue).*

Much confusion has arisen from the fact that Linnæus considered this grass to be a mere strain of *F. elatior*. Hudson first gave it the rank of a distinct species under the name of *F. pratensis*. Continental botanists still follow Linnæus and call it *elatior*, reserving for the larger species, known by English botanists as *elatior*, the title of *Festuca arundinacea* or *Festuca littorea*. We have now, however, to deal with the smaller species known as *F. pratensis* by English botanists.

This grass is common in Great Britain and on the Continent of Europe, and its presence is a pretty certain indication of good land. In situations adapted to the requirements of this grass it scarcely suffers from winter cold or white spring frosts. It flourishes in strong, deep soil, especially in low-lying meadows and valleys where a moist atmosphere prevails; and in this country it is rarely successful at an elevation of 500 feet above the sea level. Meadow Fescue is abundant in the Vale of Aylesbury, which is noted for the luxuriance of its pastures. In well-drained clay districts it is specially at home. Professor Buckman says: 'In rich meadow flats, as in the Vale of Berkeley, the celebrated locality for the production of Double Gloucester cheese, the *Festuca pratensis* is a common and valuable denizen.' Again he says: 'In an agricultural point of view *Festuca*

pratensis is indicated for best lowland pastures not liable to floods.' Scarcely any grass equals this for land under irrigation, although it is entirely unsuited to a water-logged soil.

Some writers have recommended Meadow Fescue for one or two years' leys, but as it requires three years to attain maturity, I cannot advise the sowing of it for less than three or four years. I regard it as a landlord's grass, to be used principally for permanent pastures.

Festuca pratensis is a midsummer grass, rarely flowering until the end of June, or ripening seed until the first week in August. The ripening of seed lowers the nutritive quality, but it does not greatly diminish the bulk. Sinclair's experiments proved that between the time of flowering and the perfecting of seed the depreciation in feeding value was very serious indeed. But there is no need to anticipate loss on this ground, because, being a late-flowering species, the hay is almost always cut before the danger becomes imminent. One other point deserves mention here. In early districts, where hay is cut in the first or second week of June, this grass will not be at its best, and therefore it should be sown more sparingly than where the hay harvest occurs about midsummer.

The introduction of Meadow Fescue into America in recent years furnishes another example of an alteration in character which such a change sometimes brings about. The time of flowering is much earlier there, the plant thrives at a higher altitude, and it often grows four feet high, instead of only about two feet high as in England. In East Tennessee it flourishes and makes superior hay at 1,500 feet above the sea level. The verdant growth during winter in North Carolina has secured for it the name of 'Evergreen Grass,' and in Virginia it is known as 'Randall Grass.'

In habit Meadow Fescue resembles true Perennial Rye Grass, but the herbage of the former is more leafy, and the seed-culms fewer. On light thin soils, and at altitudes where *Festuca pratensis* is unsuitable, an additional quantity of true Perennial Rye

Grass, combined with *Festuca duriuscula* and *Festuca ovina tenuifolia*, may well take its place.

Although Meadow Fescue occasionally grows rather rank, the herbage is always tender and succulent, and the quality of the hay first-rate. With cattle the plant is ever a favourite, and, if possible, is even more relished than Foxtail. These two grasses flourish under the same conditions, except that the Fescue scarcely stands heat as well as Foxtail. For practical purposes I am inclined to regard *Festuca pratensis* as the better grass, especially as the germination of the seed is more reliable, and experiments have shown its decided superiority in bulk. Up to the time of ripening seed an acre produced 209 pounds more nutritive matter than did an acre of Foxtail in the whole year. The early growth of Meadow Fescue is not large by comparison, but before the end of June it leaves Foxtail far behind. After the crop of the latter has passed its prime, the former continues to grow, and thus maintains a supply of herbage which would otherwise be wanting in the pasture. At the time hay is cut Cocksfoot is superior in bulk, but Meadow Fescue largely atones for the deficiency by its increased production afterwards.

Stock show a marked preference for Meadow Fescue over Cocksfoot, if the latter is allowed to grow the least old. The one is invariably eaten down close; the other is frequently permitted to develop into large tufts and send up wiry culms which the animals refuse to touch. Horses also eat *Festuca pratensis* greedily, and it should always be sown for them on suitable land, especially as the paddocks are often within sight of the mansion, where constant verdure is desirable.

All points considered, this may properly be regarded as one of the most valuable, perhaps the most valuable, grass that can be sown.

The following characteristics will help to determine this species in the absence of the flowering panicle: Sheath smooth, reddish purple at base; young leaves involute (rolled) in bud; ligule very short, obtuse, surrounded by a well-marked auricle.

At Rothamstead, Meadow Fescue was evidently not at home. It appears to have some rather unexpected antipathies as to soil, and in some localities is pushed out of pastures by other grasses. Nitrate of soda and mineral manures alone seem capable of augmenting its growth. Stebler, however, speaks favourably of the effects of fresh farm-yard manure.

The botanical description and analysis of *Festuca pratensis* are given at page 152, facing an illustration.

FESTUCA ELATIOR

(*Tall Fescue*).

The name *F. elatior* given to this grass by Linnæus not only included the tall-growing variety which English botanists alone know as *F. elatior*, but under that designation he included the smaller sort, afterwards elevated into a distinct species by Hudson, which is now known in England as *F. pratensis*. Although the indigenous variety of *F. elatior* found exclusively in wet marshy places, inland ditches, and tidal waters, is so coarse and harsh as, according to Curtis, to be of little value for good pastures, Sinclair pointed out its merits as a fodder grass for strong undrained clays unsuited to the growth of the finer grasses. He also calls attention to the fact that no crop can be depended upon from the sowing of the seed, and adds: 'It does not perfect much seed, and can only, therefore, be propagated by parting and planting the roots.' Again he says: 'The seed is universally, according to all my observations, affected with a disease called *clavus* (ergot),¹ and consequently infertile.' On this ground Sinclair actually named the grass *Festuca elatior sterilis*. And Curtis, at

¹ The liability of this grass to the attack of ergot is in itself a very serious drawback, and should not be without weight in deciding as to its introduction into a meadow. A correspondent in the *Agricultural Gazette* of August 30, 1886, says:—'Tall Fescue seems to be particularly liable to attack of ergot. A large bed of this grass in the Botanical Garden here (Dublin) was perfectly infested with that abnormal growth, while the neighbouring grasses showed none.'

the beginning of the century, stated that 'the seeds of this plant when cultivated are not fertile, hence it can only be introduced by parting its roots and planting them out.'

As a matter of fact, although the *F. elatior* indigenous to this country is often sterile, continental seed is fertile, and it is saved and exported to England annually. As explained at page 42, it is known abroad, not as *Festuca elatior*, but as *Festuca arundinacea*. And Mr. Carruthers distinctly states that the '*Festuca elatior* of English authors is the same plant as *Festuca arundinacea* of the Germans.'

I need hardly say that, principally in consequence of the confusion caused by the fact that the German collectors and botanists know *pratensis* as *elatior*, large quantities of seed are sold in England under the name of *elatior* which are simply *pratensis Hudsoni*. The true *elatior* (*arundinacea*) seed is distinguishable by its larger size and the more pointed shape of each grain. It has also a very perceptible roughness on the back of each seed, the three nerves extending the whole length of the back of the grain being armed with minute spines which are easily seen under an ordinary microscope, and these spines are entirely absent in the smaller seed of the true *pratensis Hudsoni*.

Sinclair named the *F. arundinacea* of the Continent *Festuca elatior fertilis*, and he had never seen it in a wild state in this country. He says: 'This grass, which is nearly allied to the common *Festuca elatior*, perfects an abundance of seed, though not entirely free from diseased portions, and is therefore not liable to the objection which takes so much from the value of that variety (*F. elatior sterilis*). It is equally early in the produce of foliage, and flowers earlier than the barren Tall Fescue by eight or ten days. The produce is equally nutritive. For damp soils that cannot conveniently be made sufficiently dry by drains this would be a most valuable plant, either to be cut for soiling or made into hay and reduced to chaff as it might be wanted.'

The sowing of a considerable quantity of *F. elatior* (*Festuca arundinacea*) seed on certain new pastures, and the vigorous

growth of the plant, especially in times of drought, have induced Mr. Carruthers to strongly recommend the sowing of this grass on good medium loams and strong soils, and not simply, as has hitherto been advised by Sinclair and others, in moist undrained clays and fens. Whether this grass will be of permanent value under these new conditions, and on soils so different from its natural habitat, is at present an open question. Hitherto it has added considerably to the bulk of the pastures alluded to, is less coarse and reed-like than the *elator* of our ditches, and has been almost, if not entirely, free from attacks of ergot. This latter circumstance, however, is probably mainly due to the fact that the pastures in question are rarely or never laid up for hay, and therefore do not flower, and ergot cannot attack *Festuca elator* or any other grass except in the flowering stage. In the formation of pastures which are always grazed, and especially for those in low-lying districts, *Festuca elator* may be used without risk, but in prescriptions for meadows which are generally cut for hay, whatever their situation, I advise caution, not only on account of the tendency of the grass to become ergoted, but because of the extreme coarseness of the hay produced. Upon the latter point Mr. J. Gilbert Baker, of the Royal Herbarium, Kew, in referring to *Festuca elator* as found growing wild in England, has accurately stated that '*Festuca elator* is a tall, coarse grass, with stems reaching four or five feet in height, and leaves one to two feet long by a quarter to half an inch broad.'

The plate prepared for this work is from a drawing of a portion of a plant raised from seed of the foreign *Festuca elator* (*arundinacea*) sown in light garden soil. It will be seen that the plant is very strong and far more robust than *Festuca pratensis* grown alongside, and falls little short of the size which Mr. Baker describes the plant to attain when growing wild. I have adopted the distinctive name of *Festuca elator fertilis*, very happily given by Sinclair to the foreign seed-bearing variety, to distinguish it from the English variety called by him *Festuca elator sterilis*.

I may add that *Festuca elator*, whether produced by the

planting of the divided roots of the indigenous variety, or as the result of sowing seed of the Continental form—*Festuca arundinacea*—equally maintains the characteristic creeping habit of the root which is one distinctive feature as compared with *Festuca pratensis* *Hudsoni*.

When not in flower this variety may be recognised by the following characteristics of the herbage. Upper surface of the deep green leaf very prominently ribbed, and hard to the touch, especially so at the edges. The lower sheaths are striated, rough, and more or less yellow.

The botanical description and analysis are given at page 154, facing an illustration.

FESTUCA PRATENSIS—VAR. LOLIACEA

(*Darnel-like Fescue*).

This grass is the form which *Festuca pratensis* assumes in certain alluvial districts. Professor Buckman, in his 'Natural History of British Meadow and Pasture Grasses,' says: '*Loliacea* is not only found, but is constant and a most valuable grass for hay or pasture in meadows by the side of rivers, especially where subject to floods, as the Isis at Oxford, or irrigated meadows on the banks of the Churn at Cirencester.' Seed saved from pure *liiacea* plants sown in the Cirencester botanical garden brought the true spicate-flowered variety, yet in three years the plants changed to a paniced Fescue indistinguishable from true *pratensis* growing alongside; and there is no reason to doubt that true *Festuca pratensis* sown in soil which *liiacea* affects would in three or four years produce the *liiacea* peculiarities. Mr. Baker, of Kew, fully confirms, I think, the inference drawn from Professor Buckman's experiment when he says: '*Loliacea* is a mere variety of *pratensis*. My friend Mr. Watson experimented on *liiacea* in garden soil, and it simply grew into *pratensis*.' Sinclair mentions an idea which was started at the beginning of the century, that *Festuca liiacea* was a mule or

cross between Rye Grass and *Festuca fluitans*, or between Rye Grass and *Festuca pratensis*. He states the reasons why such an opinion was groundless, and Professor Buckman's and Mr. Watson's experiments seem to me to prove the accuracy of Sinclair's conclusions. Some eminent botanists still hold the opinion that *Festuca loliacea* is a cross between *Festuca pratensis* and Perennial Rye Grass. But the experiments I have mentioned, where *liiacea* plants transplanted to garden soil have reverted to the true *pratensis* type, appear to render the theory of cross-fertilisation unnecessary in order to account for a change in the character of the plants.

It is difficult, if not impossible, to obtain a true and pure sample of *Festuca loliacea*, and as land which favours the growth of *Festuca pratensis* will often in three or four years develop the chief characteristics of the former, I do not consider it worth while to attempt to procure seed of *F. loliacea*, admirable as the plant is on soils where it will remain constant.

Sinclair found that *Festuca loliacea* formed the principal part of the herbage in the meadows bordering the Trent, but he alluded to the difficulty of obtaining seed at that time, and went so far as to express the opinion that the plant could only be cultivated by root-division; and Curtis remarks: 'The seeds of this grass being in the same predicament as those of *Festuca elatior*, the plant can only be propagated in the same way.'

Glyceria fluitans, or Floating Sweet Grass, somewhat resembles *Festuca loliacea* in its flowering culms, but the two grasses are perfectly distinct. The herbage of the former is very much taller, and the habit of growth entirely different.

FESTUCA HETEROPHYLLA

(*Various-leaved Fescue*).

Festuca heterophylla was introduced into England in 1814. It comes into flower rather earlier than *Festuca ovina tenuifolia*, and ripens its seed about the middle of July. Sinclair calls it

Festuca ovina hordeiformis, or Long-awned Sheep's Fescue, and he was of opinion that at least one half of the nutritive value of the grass was lost when allowed to ripen seed. The foliage is darker and more glossy than that produced by other Fescues. It is extensively grown in France, and, although a southern plant, I am satisfied that in this country, especially in all the warmer districts, it might with advantage be sown with greater freedom than is usual on strong well-drained soils, where *Festuca ovina tenuifolia* and even *Festuca duriuscula* are liable to be overpowered by Cocksfoot. Various-leaved Fescue shows a decided partiality for calcareous land, succeeds in marshes, and grows better under the shade of trees than in the open. It is a most valuable Fescue, and indeed one of the best of the finer grasses. The early growth makes it exceedingly useful in a pasture, but the aftermath is small.

This Fescue will not alone make a homogeneous turf, as the plants form tufts which will not amalgamate; but in company with *Festuca rubra* and *Poa pratensis* it will fully occupy the soil.

The loose brown sheaths and triangular form of the harsh, long, slender root-leaves are points by which this grass may easily be recognised in the absence of the flower-head.

To ensure true seed the crop has to be grown alone, because the heads when ripe resemble other Fescues so closely that it is difficult for the collectors who pick it by hand to gather a perfectly true sample.

The botanical description and chemical analysis are given on page 156, facing an illustration.

FESTUCA OVINA TENUIFOLIA

(*Fine-leaved Sheep's Fescue*).

Under the name of *Festuca ovina* all the smaller Fescues are sometimes grouped, and much confusion has resulted from the practice. A writer will speak very strongly for or against *Festuca*

ovina, and it will afterwards appear that he was referring to *Festuca duriuscula*. Again, *Festuca duriuscula*, *Festuca rubra*, and *Festuca heterophylla* are all occasionally mistaken one for another. The dwarf *Festuca ovina tenuifolia*, or *angustifolia*, differs from them all, not only in growth, but in the seed, which is small, smooth, and of a golden-brown colour, while the seed of all the others is larger and of a darker hue.

Only a small proportion of the seed sold in England under the name of *Festuca ovina tenuifolia* is the true fine-leaved variety. From descriptions which are published in this country it is obvious that the distinguishing characteristics of the seed are unknown to some of those who offer it, and as it generally costs much more than seed of *F. duriuscula* or *F. rubra*, the great diversity in the quotations for this grass is easily accounted for.

The Fine-leaved Sheep's Fescue (*F. ovina tenuifolia*) is the smallest grass cultivated for agricultural purposes, and is perfectly distinct from other Fescues, being densely tufted, with abundance of very narrow leaves and slender flower stalks. The culm has the peculiarity of being angular, while all other cultivated Fescues have round stalks. It is said to lose this characteristic in strong soils, but I think it probable that *Festuca rubra*, which is more at home in such soils, elbows its dwarf cousin out of existence, and that this is the reason why no angular Fescue stems are there to be found. The herbage of *Festuca ovina tenuifolia* is succulent, although so wiry in appearance. The plant comes into flower the third week of June, grows from six to twelve inches high, and retains its green colour during hot dry weather. It is therefore much used in the making of lawns, for which purpose it possesses a special value, although alone it will not form a compact turf.

Where this grass grows freely it is a pretty good indication of a healthy neighbourhood.

For hay Sheep's Fescue is practically useless. The growth is too dwarf to allow the machine or scythe to take hold of it, and horned stock show it no favour. It is pre-eminently a pasture grass for sheep on poor light soils and in hilly country,

especially where the subsoil is chalk, and it is generally believed to exercise a beneficial influence on the wool. It forms a principal component of the pastures on chalk downs, where its herbage is very sweet and nourishing, and South Down mutton doubtless owes its fine flavour and quality to being fed on this wholesome grass. In Scotland it constitutes a large part of the sheep herbage of the Highlands, and all through Russia and Siberia it affords almost the only pasturage for cattle and sheep on dry, sandy, rocky soils where no other grass will grow.

Its roots penetrate to a great depth, and it is a noteworthy fact, that as the plant is unable to avail itself of nitrogenous manures it soon disappears from a pasture which is manured to suit stronger growing grasses. Hence it is most unwise to sow this grass on rich fertile land.

Fine-leaved Sheep's Fescue is peculiarly suited for autumn or, correctly speaking, for late summer sowing. The seedlings are so tiny that they are liable to be choked by spring weeds, and if sheep are turned in too soon they tear up many plants. But when well established on a poor thin soil *Festuca ovina tenuifolia* propagates itself largely by the roots, and is a match for any intruder. Full development is attained in the second or third year.

The long, slender, setaceous, folded leaves, no thicker than thread, and tightly encased by the sheaths in pairs and threes, together with the russet green of the foliage, will ensure the recognition of this grass in upland pastures.

On the soils for which Fine-leaved Fescue is specially adapted it is almost indispensable, and the feeding value is very high. It is difficult to state what quantity should be sown per acre. On good soils none, except for ornamental purposes; but on dry hilly pastures it should form a considerable part of the seeding.

The botanical description and chemical analysis are given on page 158, facing an illustration.

FESTUCA DURIUSCULA

(Hard Fescue).

The common name applies solely to the flower heads, which, when ripe, become decidedly hard. The herbage, however, is tender, succulent, and much liked by all kinds of cattle.

Hard Fescue forms one of the principal constituents of the sheep pastures of this country. On all suitable soils it is of importance in forming a close bottom to the turf among stronger-growing varieties, and in this respect is of especial service for upland pastures. Sinclair found Hard Fescue to thrive best in company with *Festuca pratensis* and *Poa trivialis*, and my own experience confirms his view. Mingled with Fine-leaved Sheep's Fescue it forms a close and nutritious crop for sheep on down land.

Early in spring Hard Fescue starts into growth, flowering at or a little before midsummer, and yields an abundant lattermath. On moist and rich soils it affords an immense amount of herbage, which sometimes grows higher than the flowers, and the plant will stand drought well when the land is in good condition. As the nutritive value is much diminished by the formation of seed, the crop should be cut in time to prevent deterioration. In hay the presence of this grass is generally indicative of superior quality, and mountain graziers insist that Hard Fescue contains more 'proof' than many varieties that receive a higher character from the chemist.

Festuca duriuscula is more robust in growth than *F. ovina tenuifolia*, and occupies a position among the smaller Fescues similar to that filled by *F. pratensis* among the taller species. The plant does not grow in tufts, but is perfectly distinct; the seed is larger, and is wanting in the rich golden-brown colour which distinguishes true seed of *Festuca ovina tenuifolia* from that of all other Fescues. On good soil Hard Fescue is also undoubtedly superior to Red Fescue. The foliage is less harsh,

the root is not creeping, and in dry seasons *Festuca duriuscula* is more than able to hold its own. I must also add, that in dry seasons *Festuca duriuscula* temporarily develops a partially creeping habit, and in wet seasons *Festuca rubra* becomes less creeping than in dry years. This does not make it a matter of indifference as to which of the two is sown. Each variety is constant in character on the soil which suits it, and there is waste of time and fodder in putting either plant on land where it will take several years to adapt itself to uncongenial surroundings.

The folded, almost cylindrical, stiff, deep glaucous green leaves, which radiate from the point of union of the short sheaths, and the absence of a ligule, are sufficient to determine the presence of this species in the pasture.

As Hard Fescue is the most widely distributed of the small Fescues, the seed is naturally the cheapest, and is frequently accepted for the higher priced sorts by those who are unacquainted with its appearance. This variety may properly be regarded as the least expensive and most desirable base, or bottom-herbage grass, of a permanent mixture for all soils that are not very wet. But for alternate prescriptions it should be used cautiously, because on some soils the plant is difficult to eradicate, and after a ley is broken up it is often troublesome among corn.

Stimulating manures do little or nothing for Hard Fescue; they only encourage other grasses at its expense. At Kidmore the bone plots exhibited the most favourable results.

The botanical description and chemical analysis are given on page 150, facing an illustration.

FESTUCA RUBRA

(*Red Fescue*).

The common name is derived from the reddish-brown colour of the lower leaf-sheaths. The difficulty of obtaining pure seed of this grass has fostered the frequently expressed opinion that it

is only a form of *F. duriuscula*. But besides a more robust habit it is further distinguished by its creeping roots, which enable the plant to remain green and succulent when other grasses are burnt up. For this creeping tendency Red Fescue has sometimes been wholly condemned, and, although I cannot go that length; I am quite of opinion that Hard Fescue is infinitely superior, except for poor dry harsh soils, and on upland pastures where the employment of the former may fairly be considered essential, especially for its great power of withstanding drought. This quality naturally fits it for use on railway slopes, and for all burning soils and hot climates. Yet it will endure both cold and shade; indeed under these conditions it produces most herbage. On deep soils where Meadow Fescue will thrive this grass is out of place.

Red Fescue shoots rather later in the spring than Fine-leaved Sheep's Fescue, and produces an abundance of small herbage which fills up the bottom of a pasture, and also renders it serviceable in ornamental grounds. It flowers in June, ripens seed about the middle of July, and is one of the few grasses which improve as they get older, the leaves and stems being actually more nutritious, as well as of superior bulk, at the time of ripening seed than earlier in the season. All cattle like it, and it is so great a favourite with hares that a quantity should be grown where this game is preserved in large numbers. For hay it is of small utility, and the lattermath is inconsiderable. Red Fescue must be regarded as especially a pasture grass. Sinclair believed it to attain perfection in the second year, and limited its duration to seven or eight years.

In the absence of the flowering culm, the reddish purple base of the short sheaths, and the long, flexuous, shining, deep green, half-closed leaves, together with the pale-red underground stolons, are a sufficient guide in determining this variety.

The seed is larger than that of *Festuca duriuscula*, and germinates well—decidedly better in the open air than under artificial conditions.

LOLIUM PERENNE

(Perennial Rye Grass).

An American writer enumerates between sixty and seventy varieties of Rye Grass, but no great experience is needed to discover that in so long a list there are more names than sorts. The majority are mere synonyms; others are selections having no permanent character; so that for practical purposes the number may be reduced to about half a dozen.

Lolium perenne was the first grass gathered separately for agricultural purposes. It is better known and more frequently used than any other species, and notwithstanding recently expressed opinions that it is biennial and not perennial, I am satisfied that it is entitled to the name by which it has been known since 1611, the date of the earliest agricultural book which mentions it. That this grass is not perennial on all soils, nor under adverse conditions, may be freely admitted, and few, if any, grasses are. But when true Perennial Rye Grass seed is sown on soil that is adapted for it, and its natural requirements are met, it will prove a lasting plant.¹

¹ Since the first edition of this work was issued, I have received from eminent authorities upon Grasses many confirmations of this opinion. Sir John B. Lawes has written me approving this view, and has also published convincing evidence which he obtained as to the permanent character and valuable qualities of Perennial Rye Grass. Sir John visited Leicestershire for the express purpose of examining the famous ox-pastures of that county, and subsequently had the herbage of the best two pastures carefully analysed. The report establishes beyond a shadow of doubt the fact that *Lolium perenne* is the grass of which the pastures in question principally consist, and that it must have existed in them for more than forty years, although during that time it has never been allowed to seed. Further, it is clearly shown that the pastures actually owe their high reputation to the abundant presence of Perennial Rye Grass and White Clover.

Dr. Fream has, in an article published in the *Mark Lane Express*, made the following observations: 'Readers who are familiar with what may be termed the "grass literature" of the last half-dozen years will turn with some interest to Mr. Sutton's remarks on Rye Grass. He writes in no dubious tone.' A verbatim quotation of the above paragraph is given, followed by these remarks:—'I am bound to express my concurrence with the position Mr. Sutton takes up. Numerous confirmatory cases have come under my notice, of which I need only mention one. In the natural herbage of the water-meadows bordering the Hampshire Avon, *Lolium perenne* is, as I have found from repeated ob-

Perennial Rye Grass was in this country first sown in the Chiltern parts of Oxfordshire, and is still of great service in some portions of that district on cold sour clays, and on light stony land so deficient in lime that it will not grow Sainfoin.

The eminent Swiss botanist, Dr. F. G. Stebler, describes it as 'one of the most valuable plants in our meadows. For pasture on clay soils it cannot be replaced by any other plant, and therefore it is largely used in mixtures for forming pasture grass of best quality. In the North of Germany there are even experienced growers who only sow Rye Grass with a little White Clover. *The duration of this plant varies much according to soil and climate.*' I have put the last sentence in italics, because in this remark Dr. Stebler has accurately indicated the origin of the diversity of opinion which prevails concerning the period of existence of this grass. For while Rye Grass is indigenous and perennial in many districts, it will stand for only a limited time under other conditions of soil and climate. On a burning sand or thin gravel it is never permanent, but it answers on a gravelly clay, is at home on all loams, and positively revels in tenacious land. Even pure clay is not too stiff for it. The poorer and drier the soil, the shorter will be its duration. On the contrary, the richer and more moist the land, always supposing the drainage to be good, the greater the certainty that Rye Grass will be permanent. It responds quickly to irrigation, either of pure water or of liquid manure, but stagnant water soon kills it. The habit of the plant points to the secret of successful treatment. It roots

servation, a constant and by no means insignificant constituent. These meadows are invariably cut before the Rye Grass has time to ripen, much less to shed its seed, so that the continued presence of this grass can only be due to its perennial character.'

In the *Journal of the Royal Agricultural Society*, Second Series, Volume XXIV. Part II. No. XLVIII., Dr. Fream published an exhaustive report on the turfs he had collected for the express purpose of ascertaining the composition of the herbage in the old pastures of England and Ireland which had a special reputation for high feeding quality. With one exception each of the turfs showed a large percentage of Perennial Rye Grass, and he stated that 'the premier position is taken by *Lolium perenne*.' And in the *Journal of the Royal Agricultural Society* issued in June 1890, Dr. Fream says emphatically: 'It is but fair to myself to state that this investigation was entered upon without any reference to, or even any thought of, what is known as the Rye Grass Controversy.'

in the surface soil, and as poor land speedily becomes exhausted by the rapid growth, of necessity the plant dies.

Pastures which are stimulated by the droppings of cake-fed cattle, or which are dressed at proper intervals with farm-yard manure, continue to grow Rye Grass year after year without re-sowing. Of course if a crop of hay is cut early enough, seeding is impossible, and if the pasture is grazed the cattle will take care that seed does not ripen, for they never permit the heads to flower, but keep both culms and herbage cropped close, although Cocksfoot culms in the same field are allowed to become an annual nuisance.

Perennial Rye Grass will grow under conditions that are fatal to other grasses; it is the most certain to germinate and to produce a crop; it comes quickly to maturity, and is uninjured by the tread of cattle. While other grasses are dependent upon season and weather, Rye Grass is able to hold its own under all circumstances, enduring winter frost and summer heat. Another great advantage is that it is so little deteriorated by being allowed to grow old before it is cut. In fact, there is no doubt that it improves in quality as it becomes nearly ripe, and probably the discrepancies between some chemical analyses and the experience of farmers in feeding stock are traceable to the too early cutting of the crops.

The high feeding value of Perennial Rye Grass is shown by Dr. J. Augustus Voelcker's report and analysis, which are given at pages 138 and 162, from which it will be seen that of the larger grasses only Foxtail is superior to Perennial Rye Grass in nutritious properties. Experiments which have been made by feeding cattle on hay composed exclusively of this grass confirm my estimate of its valuable qualities. It also deserves to be widely known that Rye Grass straw cut into chaff is a very substantial food for cattle. An experienced grower, probably the largest cultivator of Rye Grass in this country, informed me that he always prefers giving his store cattle and horses the chaffed straw of Rye Grass, when it has been harvested in good condition, to feeding

them on meadow hay cut from an old pasture, and that both beasts and horses show a preference for the former.

Morton's 'Cyclopædia of Agriculture' contains the following remark on this subject: 'According to M. Péan de Saint-Gilles, a French agriculturist, the ripe straw left after threshing out the seeds is a better fodder than hay made from the green straw. After giving many thousand trusses of the straw to his horses without other food for several months, he found that they ate it as readily as the finest hay, and that it kept them in high condition.'

The objection occasionally urged against Rye Grass, that it does not produce an aftermath, only holds good as to starved crops, and on soils which are not adapted to grow the plant. Its very cheapness has been given as a reason for not using it. In the best sense of the term Rye Grass is cheap as compared with many natural grasses, but surely this is a special argument in its favour. It is quite true that *Festuca pratensis* possesses many of its good qualities and excels it in aftermath, but the difference in the price of the two articles is considerable, and the Fescue is distinctly inferior in nutritive qualities, except in its early stage of growth.

The highly glazed leaves of *L. perenne* are sufficient to distinguish it at all seasons of the year. The leaf is narrow-tipped, has an obtuse ligule, surrounded by an auricle or collar-like portion of the blade; whilst the younger leaves are folded throughout their length on the mid-rib when emerging from the purple sheath.

One of the main reasons for including Perennial Rye Grass in mixtures for permanent pastures is its reliability, already alluded to, for ensuring a plant. This is a matter of great importance, for if grasses do not occupy the ground in the first season, weeds will inevitably do so. And the Rye Grass yields a bulk of hay during each of the first two years such as could not possibly be obtained without it. Again, the Rye Grass fosters the growth of other varieties and aids the general

progress and development of those grasses which are slow in coming to maturity. On all these grounds I advocate the use of Perennial Rye Grass seed in prescriptions for permanent pastures. Even on land unsuitable for maintaining Rye Grass permanently, excellent service will be rendered by the plant while it lasts. On such soils it will yield up its place when other kinds are sufficiently established to occupy the land, but meanwhile crops of valuable herbage will be secured.

Most of the Rye Grass seed sown in England is saved in Scotland and in the North of Ireland, and I have no doubt that its acclimatisation in those cold districts tends to maintain its hardiness and its permanency. But the popular notion that the first year's crop of Perennial Rye Grass seed produces only an annual plant is a mere fiction, although to ensure all the crop being the perennial variety maiden seed should be rejected for permanent pasture.

For alternate husbandry Perennial Rye Grass may be regarded as indispensable for all soils. Even on land where it certainly would not be permanent, it should be liberally sown for a short term of years. The excellence of its herbage, the great weight of produce, its early and late growth, and the important fact that it endures the trampling of stock, are all strongly in favour of its free employment.

The endurance of Rye Grass under severe treading deserves more than a mere passing mention. By the sides of country roads a thick formation of turf, the envy of those who wish to make a lawn, is often observable; and this turf will be found to consist almost exclusively of Rye Grass. On one occasion, in company with Mr. Carruthers, we both at the same instant noticed the strong development of Rye Grass at the gate of one of my pastures, then laid up for hay, where cattle usually congregated before milking-time when the field is grazed. Examination proved that the Rye Grass was also prominent on the green path across the field. Had the extraordinary growth been near the gate alone, the inference might have been drawn that the increase

of such a gross feeder as Rye Grass was attributable to the droppings from cattle kept waiting there; but as the herbage throughout the entire length of the path, which traverses several different soils, is nearly all Rye Grass, it affords evidence of superiority over every other grass in the capability of the plant for enduring the tread of man and beast. This characteristic accounts for the large proportion of Rye Grass in the grass lands of this country which have been depastured from time immemorial.

Exceptionally heavy dressings of nitrogenous manures applied to Rye Grass when in mixture with other varieties for a hay crop are inimical to its existence because the manures enable coarse grasses like Cocksfoot to obtain the ascendancy. But Rye Grass sown alone, or when mixed with Broad Clover only, is greatly increased by the application of manures, proving that the plant has no inherent objection to them. Both at Chiswick where it was grown alone, and at Rothamstead where it only formed a portion of the herbage, moderate doses of nitrate of soda had a marked effect upon its growth, and the fact was especially noticeable that the nitrate produced an immense amount of root-fibre as well as leafy herbage. And it is interesting to find that at Rothamstead, after decreasing for three years, Rye Grass then slightly increased in proportion to the other surrounding grasses, thus evidencing its perennial character. The ammonia salts which proved so powerful a stimulant to some of the coarser grasses did not benefit Perennial Rye Grass sufficiently to enable it to hold its position against them. Only on the nitrate plots did it maintain its place. At Kidmore the plant flourished in the bone plots.

The botanical description and chemical analysis of Sutton's Perennial Rye Grass, a branching variety, considerably dwarfer than Pacey's, and still more perennial in character, are given on page 162, facing an illustration.

LOLIUM VULGARE. L. ANNUM

(Common or Annual Rye Grass).

The seed of this plant is larger and flatter than that of the Perennial and Italian varieties. It is almost as broad as the seed of *Bromus mollis*, but is lighter and lacks the awn. The plant is not so well known as it deserves to be, for it possesses valuable properties, yielding a good bulk of nourishing herbage of a light green colour, and sending up a dense mass of flowering culms. The roots being small are more easily got rid of when the ley is ploughed than are the roots of the Perennial variety; and there is a general concurrence of opinion that for a plant of such rapid growth it does not greatly impoverish the land for the next crop.

The objections which have been urged against the use of Perennial Rye Grass in mixtures for permanent pastures are largely owing to the improper employment of Annual Rye Grass in its place. The latter is only adapted for one year's ley, and its use in a permanent prescription is indefensible. Most of the advantages of the annual variety can be obtained from its more permanent relation, but reliable seed of the former is more difficult to procure, and it is generally more expensive.

LOLIUM ITALICUM

(Italian Rye Grass).

I would preclude the possibility of a misunderstanding by saying at once that this grass is only under consideration here in its proper connection with alternate husbandry. In a permanent pasture it is generally harmful, and the seed should rarely be included in a prescription for that purpose. Italian Rye Grass was probably first cultivated in Lombardy, and spread thence through Europe. It was introduced into England in 1831 by the late Mr. Charles Lawson, of Edinburgh, an old friend of my father's.

At first Mr. Lawson imported it from Hamburg, but a few years later he was able to obtain it from Leghorn. The experiments made with Italian Rye Grass by the late Mr. William Dickinson resulted in crops which were then considered marvellous, and for many years his name was prominently associated with it. His system of irrigation with liquid manure no doubt suggested the idea of sewage treatment, and it is not too much to say that without Italian Rye Grass the present method of sewage farming could not be carried on. There is no other green crop, except perhaps *Bromus inermis*, which can be substituted for it, or which will yield equally valuable herbage.

There are considerable variations in the character, productiveness, and longevity of the several strains of this plant; still, roughly speaking, all are biennial. The seed which is imported from the Continent yields a very heavy crop, but is so infested with pernicious weeds as to need most careful cleaning before it is fit to sow. To avoid this risk of making the land foul, seed has long been grown in England, and continuous selection has developed all the good qualities of the imported stock, except its extreme vigour. *Lolium italicum Suttoni*, which is now largely grown, was obtained by careful selection of the most free-growing and leafy plants. It grows with extraordinary rapidity, with but a small proportion of stalks, so that the crop, whether green or made into hay, is of specially fine quality.

Italian Rye Grass will grow in almost any soil, but is least satisfactory on poor dry land, unless it can be freely assisted with liquid manure. Still, fair results have been obtained from heaths dressed with marl and farm-yard dung. This grass flourishes in warmth and moisture, and in rich damp soils the growth is extremely rapid. Irrigation by liquid manure results in enormous crops following each other in surprisingly swift succession; and, although the plant is succulent beyond comparison, it is very hardy, remains uninjured by our coldest winters, starts earlier and grows later in autumn than any other grass.

Italian Rye Grass is so much preferred by stock, that when a two years' ley which contains it is fed off, the cattle will not allow a single flower-stalk to ripen. It promotes a great flow of milk, and improves the flavour of butter and cheese. The celebrated Parmesan cheese is said to be made from the milk of cows fed entirely on Italian Rye Grass.

No wonder, therefore, that with such remarkable qualities the plant should have been tried, and be still largely used, for permanent pastures, although nearly every authority has pronounced it unsuitable for that purpose. It is so gross a feeder as actually to choke and smother the Poas and finer Fescues, instead of simply nursing and sheltering them from scorching heat and severe frost as the slower-growing Perennial Rye Grass does. Valuable as Italian Rye Grass is for alternate husbandry in the company of other strong-growing grasses, such as Cocksfoot and Timothy, I have always objected to its use in permanent pastures, even during the years when the contrary custom prevailed. This view is now admitted to be sound, and the circumstances must be altogether exceptional which warrant the use of it in forming a permanent pasture.

With singular inconsistency, some writers who disapprove the use of Italian Rye Grass in a mixture of permanent grasses, advocate its employment for renovating an old pasture. A more illogical proposition has never been made, for when the brief existence of the Italian Rye Grass terminates, the pasture will be left in a worse state than before.

There is a prejudice against this grass because it severely taxes the soil, and it is quite true that Italian Rye Grass will appropriate all the nourishment it can get. But that is an argument in its favour. It means that the plant is a powerful agent in extracting material from the soil, which it yields up in valuable food for cattle. Given the desire of obtaining from an acre of liberally fed land the largest possible produce within twelve months, and Italian Rye Grass has no equal for fulfilling the condition.

Another prejudice is that Italian Rye Grass is a bad preparation for wheat. On that point Mr. Dickinson's own words can be quoted: 'Thirty sheep may be kept upon Italian Rye Grass, fed through hurdles, upon as little land as ten can be kept upon the common system upon common grass, and the finest crops of wheat, barley, oats, and beans may be grown after the Italian Rye Grass has been fed off the two years of its existence. Wheat invariably follows the Italian, and splendid crops are grown.'

Again, it is objected that twitch is produced by Italian Rye Grass. With pure seed this is impossible, but plenty of Italian Rye Grass seed with twitch in it is freely bought and sold every year. The remedy is in the buyer's own hands. But if twitch is already in the soil, a starved crop of Rye Grass may give the couch an opportunity of asserting itself. Still the tendency of a well-fed and frequently cut crop of Italian always favours the destruction of twitch.

Italian Rye Grass is very commonly sown with Broad Clover, and in composite mixtures for alternate husbandry. It may also be used with *Avena elatior* when a more durable crop is wanted than can be obtained from Italian Rye Grass only. But the most profitable way of growing it is alone, because the crop can then be cut before any of the stalks become hard and lose their nutritious qualities. Another reason why Italian Rye Grass should not be allowed to grow old is that the plant is extremely succulent, and in warm thundery weather there is a risk of the roots beginning to rot. On this account a very bulky crop cannot, in a hot, damp summer, be safely left for seed.

Seed may be sown at any time from spring to autumn. The usual months are February, March, September, and October, and the quantity three bushels per acre. The plant is rolled in spring, the crop is cut frequently, and the land broken up in the following spring twelvemonth. Many farmers make it a rule to sow in October, and on warm moist soils crops have sometimes been cut at Christmas, and again in the following April. Such experience,

however, is exceptional, but it proves the endurance and fertility of the plant.

The botanical description and chemical analysis of Sutton's Italian Rye Grass are given on page 164, facing an illustration.

PHLEUM PRATENSE

(*Timothy, or Meadow Catstail*).

To see this grass in perfection a visit must be paid to the United States, where it is grown alone, and yields amazing crops of hay, three, four, and in one recorded instance six feet high. In the pastures of that country our finer meadow grasses are unknown; therefore Timothy is more highly prized than with us. It is supposed to have been introduced into England for agricultural purposes about the middle of the last century, and is now widely distributed. The plant is perennial and fibrous-rooted, except under certain conditions when the root shows a tendency to take a bulbous form.

To sow Timothy on sandy or dry gravelly soils, or on mountain pastures, is useless; but it luxuriates in clay districts and on moist soils, and is unsurpassed on peat. Its character varies greatly in different soils and situations. It is one of the most certain grasses to grow, and is specially serviceable in the company of Foxtail, because it fills the interval between the first growth and the aftermath of that grass. Another substantial advantage is that the plant reaches the height of its productiveness in the first year after being sown, but unless it is properly fed there is a tendency to weakness in the third or fourth year; and considering the severe tax which such a plant necessarily makes on the soil, this will occasion no surprise.

No other grass will bear extremes of heat and cold better than Timothy, and in rigorous winters, which severely test the endurance of other hardy varieties, this will pass through the trial uninjured. Timothy produces a heavy hay crop, is exceedingly nutritious when young, and becomes still more so when old and

the seed is formed. Of course, if the plant is permitted to mature seed, little or no aftermath is to be expected. All cattle eat it greedily, and horses manifest especial fondness for it.

Timothy is generally spoken of as a late grass, and correctly so, because it flowers in July. Still the early herbage is good, and sheep may be run over a pasture containing a large proportion of it until late in spring without endangering the crop of hay. Indeed, it frequently happens that the herbage must be fed off before being laid in for hay, to prevent the Timothy from being ready before other grasses are fit to cut. Timothy is really mown to greatest advantage before the ears are out of their sheaths, having regard to the fineness of the hay and the aftermath. It should be clearly understood that I am here alluding to the treatment of a meadow containing an unusual quantity of this grass, from which superior hay is wanted. When grown alone as a fodder plant, Timothy may not only be allowed to remain uncut until in full flower, but even for ten days or a fortnight later, and during that time the nutritive value will be augmented. Sinclair says that, 'subject to the weather being such as to keep it in growth, every two days' growth after flowering will increase its nutritive value as much as any eight days' growth before that period.' Still, it must be admitted that these hard wiry stalks, when dried, can scarcely be called hay. If mixed with other grasses in hay, they will reduce its selling value. They may be very nutritious, but they will have to be cut into chaff before being given to cattle.

The greyish-green tint of the short, broad leaves, and involute character of the emerging leaf, together with the smooth sheath and obtuse ligule, clearly distinguish this grass from others when the cylindrical flower-spike is wanting.

Timothy should form a principal constituent of every permanent prescription intended for heavy soils, but as there has been a tendency of late years to give undue prominence to this grass, I think it necessary to say that mischief may be done by using it in excess. It is decidedly inferior to Foxtail. The

herbage is coarse, the stalks soon become hard, and their increased feeding value in that state is of no avail if cattle refuse to graze them, as they undoubtedly do ; or if the presence of this grass in abundance lowers the price of the hay. When seed is freely shed there is a danger that the plant will take almost exclusive possession of the land, especially on those formations which favour its growth. And once sown it is a very difficult grass to eradicate. All points considered, great judgment is requisite in order to realise the full advantage of Timothy, and at the same time to maintain the general efficiency of the pasture. It certainly should not be sown where hay of fine quality is an absolute necessity.

Timothy is not so suitable for sowing with clovers for alternate husbandry as other grasses, because of its late flowering ; but with Cow Grass, which flowers considerably later than Broad Clover, this difficulty does not arise, and perhaps it would be impossible to find two plants which could more suitably be sown together. For alternate husbandry Timothy offers very substantial benefits, and the only objection to its employment for a term of years is the trouble experienced in getting rid of it when the ley has to be broken up.

In the Kidmore experiments with manures, sulphate of ammonia appeared to have a very marked effect in promoting the growth of this grass.

The botanical description and chemical analysis are given on page 166, facing an illustration.

POA PRATENSIS

(*Smooth stalked Meadow Grass*).

Although there is a general resemblance between this grass and *Poa trivialis*, the two plants differ materially in habit, character, and structure. *Poa pratensis* is unlike *Poa trivialis* in having broader and blunter foliage, an obtuse ligule to its leaf, smooth stalks, and creeping roots that send out long stolons which take a

horizontal direction and send up little tufts. Each variety has a value of its own, and is fitted to serve a purpose which the other is less adapted to fulfil. *Poa pratensis* is naturally suitable for enduring drought, while *Poa trivialis* thrives in moisture. This is the chief constitutional difference between the two plants, and although each of them will to some extent conform to the conditions which specially favour the other, yet the distinction clearly indicates the use to which each one should, as a rule, be applied.

Poa pratensis does not root very deeply, but is dependent principally upon the surface soil, and is therefore met with on all geological formations if the surface happens to be suitable. All eminent authorities concur in recommending its use on good dry soils, and my own experience has convinced me of the correctness of their opinion. But light land must be rich in humus to ensure success, and this shows that the plant is unfitted for sand. On heavy and tenacious soils it will often grow, but is not then seen to the greatest advantage.

During the first year *Poa pratensis* remains small, and does not throw up any stalks, and when fully established it is a marked characteristic of the plant that it only flowers once a year. After the stems are cut, no more grow until the following season. The plant needs liberal feeding, and is primarily a pasture grass, because the flowers come too early for the scythe. Otherwise, for very forward cutting it is valuable for hay, and then produces a good aftermath of leafy herbage. The secret of its earliness is that the plant appears to be insensible to cold, continuing to grow during spring frosts. Its presence in large proportion in a pasture will, by the shelter it affords to other varieties, make that pasture an early one, and this fact strongly commends it to the grazier, for a ton of feed at the end of March or the beginning of April is of far higher value than it is a month later.

For lawns, Smooth-stalked Meadow Grass may be freely sown, as it is strictly perennial, overpowers weeds, and forms a fine compact turf.

In the West of Ireland, where this grass grows all the year round, it should be largely used ; and, as one of the most suitable grasses for fogging, it should be serviceable in Wales. For railway embankments or other situations where a rapid matting turf is wanted for holding the soil together, there is no more valuable plant.

In the United States, where *Poa pratensis* is known under the name of Kentucky Blue Grass, or June Grass, it has been cultivated with striking success, and when it has taken possession of a pasture the value of the land is immediately enhanced. Americans grow it on their richest soil, and are surprised that we use it so little and never sow it alone. But in some parts of New Zealand this grass has developed a very objectionable habit of growth. It overruns pastures, and is difficult to eradicate from arable land when once it has obtained a footing. This fact does not prove the worthlessness of the grass for British use. It is analogous to the case of our familiar Sweetbriar, which since its introduction into Tasmania forms dense thickets in that country, entangling and overpowering all other vegetation, throwing underground suckers across fields, and matting the soil with its dense mass of fibre. But we are not on that account inclined to sacrifice the charming bush of our gardens and hedgerows. Neither the merits of *Poa pratensis* when cultivated in America, nor its demerits when sown in certain districts of New Zealand, however interesting they may be, need influence our estimate of the value of a grass which experience has proved to be of great service in this country.

The rounded, concave tip of the leaf, together with the obtuse ligule, the yellowish green of the lower sheaths, and short stolons, will suffice for determining the presence of this species in a pasture.

Dressings of nitrate of soda discourage the growth of this grass, while mineral superphosphates combined with ammonia salts foster it. At Kidmore decorticated cotton cake was also conducive to the growth of *P. pratensis*.

The botanical description and chemical analysis are given on page 168, facing an illustration.

POA TRIVIALIS

(*Rough-stalked Meadow Grass, or Orcheston Grass*).

This variety differs from *Poa pratensis* in having narrower foliage, a long pointed instead of a blunt ligule to its leaf, fibrous instead of creeping roots, and slightly rough sheaths. The roughness is only apparent to a sensitive touch, but is readily perceived when the grass is drawn across the tongue.

Poa trivialis was first sown about 1780, and of late years it has been mistakenly recommended for all purposes. On strong moist soils, where *Poa trivialis* is quite at home, it surpasses *Poa pratensis* in quantity and in quality, but the favourable comparison does not extend to light land liable to burn, on which the superiority of *Poa pratensis* becomes manifest. The plant is liable to injury by spring and autumn frosts, and also by severe winters. It is rich in potash and phosphoric acid, and soon exhausts land which is not good or constantly fed.

This grass forms a large part of the natural turf of the valleys in mountainous districts where the rainfall is considerable. It thrives under trees, prospers in water-meadows and all moist dripping situations, and bears well the hoofs of stock, but it must be mown before the foliage turns yellow at the base, or it is liable to rot. Sinclair says that it is unprofitable for any purpose on dry exposed situations.

Poa trivialis flowers at the time when hay is cut, but is especially useful for pastures nevertheless. The herbage is of more value at the time of ripening seed than before, but as ripening does not take place until the end of July, it is impossible in the South of England to keep the hay crop waiting for it. The aftermath is good after early cutting only. Sinclair advises its use exclusively for permanent pastures on rich soils and in sheltered positions, and I quite agree with this view.

Valuable as this grass is for such situations, I do not consider that for any other land it is worth while to incur the cost of seed, which, if true, is always expensive. Wherever *Poa pratensis* will answer, it should be used instead.

This species is recognisable by the slender leaf which gradually tapers from the base to the tip of the blade, and has a well-marked keel. The young leaves are compressed, and folded on the mid-rib; whilst the lower sheaths are loose, and tinged violet-purple; ligule truncate.

At Kidmore nitrate of soda and muriate of potash had a marked effect on the development of this grass, while, on the contrary, ammonia salts diminish its growth. The Rothamstead experiments have clearly established the fact that in this respect it differs altogether from *Poa pratensis*.

The botanical description and chemical analysis are given on page 170, facing an illustration.

POA NEMORALIS SEMPERVIRENS

(*Hudson's Bay or Evergreen Meadow Grass*).

Grows very early in spring, yields a greater bulk of herbage than *Poa pratensis*, bears drought remarkably well, and is the most valuable of the cultivated Poas. For lawns and ornamental grounds it answers admirably, and is indispensable for sowing under the shade of trees. The seed is too costly, and the supply too uncertain, to warrant a large use of it in ordinary grass-land farming.

The very short sheath—not more than one quarter of the length of the flat blade—together with the lacinated, obtuse ligule, and the compressed character of the younger leaves, are points by which this variety may be recognised when not in flower.

The botanical description and chemical analysis are given on page 172, facing an illustration of the plant.

POA AQUATICA

(*Water Meadow or Sweet Reed Grass*).

Adapted for low-lying land subject to floods, nutritious, and generally liked by cattle. In the Fen districts it forms a large part of the herbage, and yields abundant crops of hay. It is suitable for sowing in water meadows, and may be included in permanent mixtures for undrained clay. The flowering occurs in July and August.

AGRICULTURAL CLOVERS

(*LEGUMINOSÆ*).



TRIFOLIUM REPENS PERENNE

(*Perennial White Clover*).

THIS plant was first cultivated in the Netherlands; hence the familiar name, Dutch Clover. It is said not to have been sown in England until the beginning of the eighteenth century, although it is indigenous all over the country. The seed will lie dormant for a long time and at a great depth, and be ready to spring into life when brought to the surface. The habit of the plant is creeping, and when once established it soon covers the ground. Sometimes its luxuriance is excessive, and the abundance of flower heads, which cattle dislike, becomes a nuisance. The land might then be more profitably occupied, so that in sowing White Clover judgment should be exercised. In warm, rainy seasons it spreads rapidly, but makes little or no progress during cold, dry weather. Besides the mass of fibrous surface roots there is a long tap-root which goes deep into the subsoil, sustaining the plant during drought when only the parent stem grows, the lateral and creeping shoots remaining dormant.

The character of the plant differs materially, according to the soil on which it is grown. Sinclair remarks that 'it maintains itself in soils of opposite natures,' because of its peculiarity in having two distinct forms of root. It prospers on mellow land containing lime, and on all soils rich in humus, from marl to gravel, or gravelly clay. In poor land it does better, and is less sensitive

to atmospheric influences than Red Clover, and is of great importance on land which cannot be depended on to grow Perennial Red Clover. In early spring it produces very little food, and the plant is so dwarf that it is practically useless for cutting, so that Alsike should take its place for a crop of hay. Still, Perennial White Clover forms an essential constituent of every good pasture. All cattle eat it with relish, but it is less useful for the production of milk than of flesh, and is of special service in fattening sheep. No doubt the herbage is more palatable to stock before the plant flowers than afterwards; indeed, a profusion of flowers is no indication of an abundant bite. White Clover is not suitable for culture alone, and its herbage is better for cattle when mingled with grasses, especially with Perennial Rye Grass. The Norfolk farmers largely use it for ewes and lambs, but from difference of climate the strong opinion they entertain in its favour is not shared by practical men in the West of England.

The fecundation of White Clover is aided by insects. From ten flower heads visited by bees Darwin obtained ten times as many seeds as from a corresponding number protected by gauze. On a subsequent occasion he failed to obtain a single good seed from twenty protected heads.

Ammonia salts alone reduce the plant to insignificant proportions. Nitrate of soda is little better in its effect. When other varieties of grasses and clovers are present, these nitrogenous manures result in a smaller growth of White Clover than when the land is left unmanured. Mineral manures, potash especially, with a small quantity of nitrate, considerably augment its growth, as also do dressings of marl or vegetable ash.

There is a Long-haulmed Dutch or Wild White Clover which is prized for the heavy crop it produces, but much of the seed offered under this name is unreliable, and the best of it will, after a few years' growth in an unsuitable locality, revert to the original type.

The botanical description and chemical analysis are given on page 174, facing an illustration.

TRIFOLIUM PRATENSE

(*Red or Broad Clover*).

Red Clover is said to be indigenous in every country in Europe except Greece. In a wild state its presence is a fair indication of the fertility of the soil. Although a strong-land plant it will grow on almost any soil, and contains so much moisture that only one-fifth of the weight of the green crop is found in the haystack.

Winter and spring frosts are very injurious to Red Clover, and to save the plant a top-dressing of long manure is sometimes necessary, for which, however, there is a return in due time.

A considerable diversity can be discerned in the various strains of Red Clover. Seed is imported from all parts of Europe, and large quantities from North America. Each country has one or two well-defined types of this plant, and although growers may be careful to avoid buying any but so-called English seed, the fact that the stock may only have been imported two years previously will account for the differences which are every year displayed in crops of Red Clover. The prejudice existing against foreign seed, especially that from America and France, is well founded. Experience has proved that both produce a smaller crop than seed saved from a stock which has been acclimatised in England for many years, and there is also the great danger of Dodder to be considered. The seed grown in Styria and in some districts of North Germany, however, is as robust and hardy as the English.

Trifolium pratense is quite unsuited for permanent pastures, but should form a large proportion of an alternate mixture. The great root-growth made during its two years' existence is the best possible preparation for the following wheat crop.

This Clover is incapable of self-fertilisation, and the Humble Bee is almost exclusively the medium by which pollen is conveyed from anther to stigma. In Australia and New Zealand, where

until recently the Humble Bee was unknown, seed was rarely ripened, and the Red Clover sown in those colonies was all imported, principally from England.

The character and culture of Red Clover are so well understood as to render further remark needless.

The botanical description and chemical analysis are given on page 176, facing an illustration.

TRIFOLIUM PRATENSE PERENNE

(*Perennial Red Clover or Cow Grass*).

This Clover doubtless originated in a cross between *Trifolium pratense* or Broad Clover, and *Trifolium medium* or Zigzag Clover.¹ The latter has never been in commerce, nor has it been grown as a crop except for experimental purposes. Yet some writers have fallen into the error of confusing it with the true Perennial Red Clover, which in Berkshire, Oxfordshire, Hampshire, and Wiltshire is known as Cow Grass. In these counties Cow Grass is of immense importance, and enters largely into the rotation of arable land. The use of it is extending to other parts of England, and it is astonishing that so valuable a plant has not long since been

¹ *Trifolium medium*.—The Cow Grass or Zigzag Clover of botanists is so called from the decided zigzag growth. So distinct is the plant that it can scarcely be classed with Red Clover at all. The blossom is darker in colour than that of *Trifolium pratense*, the head less dense, invariably growing on a long peduncle instead of immediately adjacent to the leaf. The absence of the broad membranous stipule, and the substitution of one which is long and narrow, terminating gradually in a spear-like point, is also a marked characteristic, by which those who have once observed this peculiarity are never likely to mistake *Trifolium medium* for *Trifolium pratense* again.

The plant is generally found by hedgesides, or on rough grassy places in dry situations, and it appears to be capable of withstanding any degree of cold or heat. The stalks and leaves are so intensely bitter that they are refused by all cattle. Not only is the plant valueless for agricultural purposes, but it is highly detrimental, occupying the same relative position amongst the *Leguminosæ* that couch (*Triticum repens*) does amongst the *Graminaceæ*.

Trifolium medium increases with extraordinary rapidity by underground stolons or roots, and if allowed to establish itself is practically ineradicable, every inch of the root, when cut with the plough, being capable of producing a plant. The agriculturist who may ever be persuaded to accept this, the botanist's Cow Grass, for the true agricultural Cow Grass—*Trifolium pratense perenne*—will have bitter cause for repentance.

widely recognised as indispensable for alternate husbandry, instead of being restricted to permanent pastures alone.

Trifolium pratense perenne differs from Broad Clover in having a somewhat taller, smoother, and except in its very young state a less hairy stem, and a stronger, less fibrous, and more penetrating root. It carries its flowers some way above the foliage, surpasses Broad Clover in succulence and weight of crop, and stands frosts much better.

The root of Perennial Red Clover reaches down into the subsoil, enabling it to obtain moisture and nourishment in the hottest weather, when Red Clover gives up from drought. This penetrating habit also affords a means of sustenance to the plant on land which is too poor to grow Broad Clover, and frequently makes it desirable to increase the proportion of this seed for pastures on thin uplands.

Perennial Red Clover has two characteristics which greatly augment its value: flowering does not begin until at least ten days later than Broad Clover, and the more robust and solid stems remain succulent and eatable by stock long after Broad Clover has become pithy and withered. Perennial Red Clover fills up the gap between the first and second cuttings of Broad Clover, coming into use at a time when no other green food is available for the horses of the farm, but it rarely gives a second crop of any consequence.

Cow Grass produces comparatively little seed from its single crop; whereas Red Clover yields a good crop of seed from the second cutting, after the first has been taken as fodder. Consequently seed of the perennial variety is necessarily high in price.

It is worth noting that Cow Grass is understood on Mark Lane, and in many parts of England, to mean no more than a fine handsome sample of Broad Red Clover. The true Perennial Red Clover is rarely obtainable except from those who make its culture a study. And, just as all Rye Grass has been condemned because the annual variety has been used where only the perennial kind should have been employed, so true Cow

Grass—*Trifolium pratense perenne*—has been disparaged because Broad Clover has been called by its name and supplied as the genuine article.

When H. M. Jenkins was in Flanders on his tour with James Howard some years ago, he found that this Perennial Clover was relied on as the chief soiling crop, and was used in exactly the same way as in the English counties I have named. So far as I am aware, however, true Belgian Cow Grass is never offered in this country, and if it were offered there would be the risk of its being foul.

The true Perennial Red Clover is an invaluable plant for permanent pastures, and should be included in every mixture for that purpose. Its presence in a pasture at midsummer, when Alsike is giving up, is of great service, and although it does not produce a second crop for the scythe, it yields a quantity of excellent feed. Perennial Red Clover is not perpetuated in pastures by seed as is commonly supposed, but from short stout branches extended from the parent plant, which root and take the place of the parent should conditions of soil or climate interfere with its perennial character.

Stebler classes this Clover, among others, under the heading of *Trifolium pratense*. He says that it bears the later and better name of *pratense perenne*, or Perennial Meadow Clover, the very designation which my father gave it. Stebler, too, notes its peculiarity of having a less fibrous root than ordinary Red Clover, that the stalks are generally solid instead of hollow, that it produces less flower and therefore less seed, and that the seed is always dear and difficult to obtain true. He also supports my view that it is much more perennial than any other Clover, and distinctly says that it is a mistake to confound it with *Trifolium medium*.

At Rothamstead, ammonia salts had the effect of eliminating this plant from the various plots to which they were applied, whether in conjunction with mineral manures or alone. Nitrate of soda also diminished the growth. Even potash and mineral

manures alone did not maintain the permanence of this Clover. It is a remarkable fact that the unmanured plots, where there was little other herbage to interfere with it, were the only plots on which Cow Grass retained its original position. The Rothamstead experiments, however, decisively proved this plant to be more enduring than *Trifolium repens*; hence there can be no doubt whatever as to its great value in laying down land to pasture.

The botanical description and chemical analysis are given on page 178, facing an illustration.

TRIFOLIUM HYBRIDUM

(*Alsike Clover*).

Although this plant was named by Linnæus, there is reason to doubt whether it is a hybrid between Red and White Clover, as is generally assumed. The common name of Alsike is derived from the village of Syke, near Upsala in Sweden, where it has been grown with great success. The plant is indigenous in Southern Europe, yet it does not appear to have been cultivated until after the example was set in Sweden, whence it reached this country.

Alsike Clover is a true perennial, and on the greensand formation comes up year after year where once it has been sown. On some light soils it is not so permanent. Were it not for the surface growth, and the consequent inability to withstand drought, Alsike would take a more important position in agricultural operations than Broad Clover, especially as the former will often grow on clover-sick land.

Alsike Clover is peculiarly adapted for damp soils, is decidedly more productive in wet than in dry seasons, endures heat and cold well, succeeds in undrained clays better than any other variety, and is the only clover that will stand irrigation. On damp soils if the crop becomes laid there is a danger of its rotting at the base, and then, if possible, it should be promptly cut.

For meadows, Alsike Clover is far superior to White Clover, as it produces a crop tall enough for the scythe, and materially adds to the total weight of hay. It also produces more keep and is better relished than White Clover. On some soils it will grow quite as much herbage as Red Clover, and as the vegetation is principally composed of leaves, care is requisite in the process of making hay, or the leaves get broken off and lost, especially as the plant is more succulent than Red Clover and takes longer to make into hay.

The time of flowering approximates to that of Cow Grass, and the nutritive value is highest at the flowering stage. The plant is not hasty in getting old and pithy, as is the case with Red Clover. After cutting, Alsike Clover shoots quickly, but the growth is low, and the total of the aftermath only equal to half the first cut. Still its value as a pasture plant is very great indeed, and it is one of the best clovers for alternate husbandry. It flourishes in the same deep moist soil as Timothy, and but for its earlier flowering would make an excellent companion to that grass. It is, however, quite at home with Tall Oat Grass, Italian Rye Grass, and Cocksfoot.

The botanical description and chemical analysis are given on page 180, facing an illustration.

TRIFOLIUM MINUS

(*Yellow Suckling*).

This clover is by no means unworthy a place in a permanent mixture, for although its growth is very small and the produce scanty on the gravelly soils and stony places where Yellow Suckling is generally found, on strong land and on the greensands it is of considerable value, forming a dense mass of herbage and seeding itself down every year. When grown with Rye Grass, and cut before it gets old, it makes excellent hay which is much relished by stock. In such a case the roots cannot be depended

on for another crop, but when pastured and kept constantly down the plant will provide a bite all the summer.

The small foliage admirably fits it for lawns and pleasure grounds.

MEDICAGO LUPULINA

(*Common Yellow Clover, or Trefoil*).

A fibrous-rooted biennial plant which flowers from May to August, and very much resembles Yellow Suckling, but the foliage is a paler green, the stems much less hard and wiry, and the flowers are not so dark. The black seed-pods, which have earned for it the name of 'Black Medick,' are also useful as a means of identification. Trefoil starts so early in spring as to give a bite before any other clover, and flowers ten or fifteen days in advance of *Trifolium pratense*.

Although the procumbent habit of growth prevents it from being of much value for the scythe, it affords a large quantity of keep in spring, but there is no aftermath worth speaking of. Primarily it is a plant for alternate husbandry, being only biennial in duration; still it propagates itself so sedulously by seed as to be practically permanent, and as chemical analysis shows the herbage to be nutritious, there is good reason for including a small proportion in most permanent mixtures, especially as it grows compactly and helps to make a good bottom to a pasture. Where it is indigenous in abundance, seed need not be sown, nor should it be admitted to those soils on which it is liable to smother other plants.

Trefoil endures cold better than heat, will grow freely on almost any soil, and shows preference for such as are calcareous, because lime is one of its necessities. Clay marl is its special home. Fresh green manure does not suit Trefoil, but a top dressing of a good compost or of vegetable ash generally brings a full crop. All manures containing potash and phosphoric acid have a magical effect on its growth.

Sheep injure it less than they do Red Clover, and it is supposed to impart colour and good flavour to butter.

Trefoil is rarely sown alone, but frequently in company with White Clover, and it is important that the latter should predominate or the former may take entire possession of the land. Foxtail, Sweet Vernal, and Smooth-stalked Meadow Grass combine well with Trefoil in affording early and valuable herbage.

The botanical description and chemical analysis are given on page 182, facing an illustration.

LOTUS CORNICULATUS

(Birdsfoot Trefoil).

This plant is strictly perennial, and attains maturity in the second year after sowing. It often fills up the bottom of a pasture when other sorts are deficient, and will do this on land which is clover-sick. Birdsfoot Trefoil is useful for all soils, and is remarkable for its endurance of drought, however extreme. There are high exposed thin soils where it is more productive than any other clover, and it seems to augment the total of the crop without detriment to the taller upright-growing varieties. Therefore, if expense need not be considered, seed in limited quantity should certainly be sown. Unfortunately such soils do not often warrant the outlay for this clover, the price of which is almost prohibitory.

*SUNDRY PLANTS USED FOR GRAZING,
FEEDING, OR MAKING INTO HAY.*

ACHILLEA MILLEFOLIUM

(*Yarrow, or Milfoil*).

ALTHOUGH neither a grass nor a clover, Yarrow is such an ever-present constituent of dry pastures that it naturally comes up for consideration here. The leaves are dense and elegantly fimbriated, and the flowering time is after midsummer. The plant is strictly perennial, and multiplies itself by root-growth. It appears to be independent of the presence of potash in the soil, and will consequently flourish where clovers can scarcely maintain existence, or fail entirely.

Yarrow is adapted for pastures, not for meadows, and seed should be excluded from the mixture for a crop that is to be generally mown. Sheep are very fond of the herbage, which is believed to impart an excellent flavour to mutton, venison, and to butter also, notwithstanding its astringent qualities.

On dry gravels and light sands that will hardly support any other plant Yarrow will grow, and no summer is too hot for it. So great is its power of enduring drought that after a dry season there is always a large demand for seed, and as this is difficult to obtain of reliable germination, the price runs up to an extravagant figure.

Ammonia salts appear to be inimical to the growth of Yarrow, nitrate less so, but heavy doses of any ammoniacal manure are certain to reduce its bulk by increasing the strength

of surrounding grasses. Mineral manures alone seem to favour its development.

The botanical description and chemical analysis are given on page 184, facing an illustration.

MEDICAGO SATIVA

(*Lucerne*).

The common name of this plant is generally supposed to be derived from the canton or town of Lucerne, in Switzerland. But Dr. Stebler controverts this opinion, although he is at a loss to account for the appellation. Lucerne was known to the ancient Greeks and Romans as a forage plant. It is mentioned by Virgil, and at the beginning of the Christian era by several agricultural writers. In Persia and other Eastern countries the plant is still used for horses.

Wet summers diminish the culture of Lucerne in England, but dry seasons always restore it to favour, although English farmers have never appreciated its merits to the same extent as their Continental brethren. In part, no doubt, this is owing to climate, and in part to soil. Lucerne is essentially a plant for dry climates and dry soils. Cold, dry air has no ill effect upon it; but moisture, with or without heat, is directly prejudicial. Its duration depends more upon the subsoil than upon the surface; indeed, the nature of the surface is of small moment so long as the subsoil is calcareous. In some parts of the Continent Lucerne remains as good a crop twenty-five years after sowing as in the third year of its existence, but five years is the usual term, and seven years may be considered the fair limit of its vigorous life even on suitable land. It is interesting to note the diverse surface soils on which Lucerne thrives, but investigation will always prove that whatever the nature of the surface may be there is a substantial agreement in the subsoils where this plant flourishes. The distance to which the tap-roots penetrate is almost incredible. In the first season they

will often go down two feet or more. I have been told of one instance where a Lucerne root was traced to a depth of sixteen feet.

But for its unsightliness Lucerne would be more frequently sown for permanent pastures than it is. The plant develops so rapidly that it stands far above the surrounding herbage, and imparts a broken and irregular appearance to the meadow. Still it must be conceded that a certain proportion of Lucerne should be included in every prescription of seeds intended for the formation of a permanent pasture where the soil or subsoil is calcareous.

In many localities Lucerne cannot be cultivated successfully, and it will only be waging a fruitless war against Nature to attempt to grow it on impervious clay, or on any cold adhesive land. Warm and calcareous soils are highly favourable to its growth, and a sheltered field, sloping to the south, will suit it to perfection, provided always that lime can be reached, for this it must have. Sometimes there is a strong desire to grow Lucerne on soil deficient in lime. To meet the requirements of the plant a heavy marling is applied six months before sowing; but the process is costly, and at best the effects are only temporary, because there is no possibility of burying the marl deep enough to feed the roots after they have pierced down into the subsoil. The richer the soil the earlier will Lucerne come to full development, and land should be chosen in which the roots will be able to strike down without undue resistance.

The principal point in the culture of Lucerne is to secure a thoroughly clean seed-bed. Weeds soon ruin the plant, and therefore farm-yard or stable manure, although good in itself, is dangerous from the seeds it may contain. Ash of all kinds is beneficial, and, of course, artificial manure can be freely resorted to. Three hundredweight of superphosphate per acre is a good dressing. The best preparation is a crop of potatoes. As a rule, April is the time for sowing, and the seed must not be deeply buried. In England Lucerne is almost always sown alone,

while on the Continent a thin seeding of corn is often put in with it.¹

When well established the herbage must on no account be allowed to grow old before being cut; in fact, the plant should not be permitted to flower.

Lucerne is rarely made into hay, as the leaves are lost during the drying, and the process is exceedingly wasteful. The most convenient and profitable way of growing it is to sow a patch near the homestead, so that the daily portion when cut has only to be carried a short distance to the stables. The plant is peculiarly rich in albumen, and is even more nutritious than Red Clover. Given alone, and especially when very young, there is a possibility that cattle fed upon it may become blown, but when chaffed with good oat or barley straw Lucerne is a wholesome and valuable food. Several cuts are obtained in a year, making altogether an immense weight of keep. It is not worth while to sow seed unless the crop can be allowed to stand for at least three years.

ONOBRYCHIS SATIVA

(*Sainfoin*).

Sainfoin is a native of England and has been cultivated in this country for over two hundred years. It is essentially a food for sheep, which in pasturing the plant do it no injury. Sainfoin is also useful for horses, but produces nothing like the quantity of green food that can be obtained from Lucerne.

In Norfolk and some other of the Eastern counties, Sainfoin takes the place of Red Clover, and is rarely allowed to remain down more than two years, generally only one. Against this practice nothing can be urged, for it is probably the best possible

¹ Mr. Clare Sewell Read tells me that he has been most successful in obtaining a plant of Lucerne by sowing it in wheat, while he has never succeeded with it in barley, and seldom when sown alone. He attributes the failure among barley to the closer sowing of this corn as compared with wheat; and the failure when sown alone to the plant being smothered by annual weeds.

preparation for wheat. But the method adopted in Berkshire, Oxfordshire, Wiltshire, and Hampshire of putting down Sainfoin alone for four or five years, has grave disadvantages. Gradually the Sainfoin plant diminishes, and every form of vegetable rubbish increases, until the land comes to be exceedingly foul. Instead of sowing Sainfoin alone, to remain down more than two years, I strongly urge its use as a predominant constituent in a mixture of grasses and clovers for three or four years' ley. The sowing of Sainfoin alone is an expensive, and more or less a precarious proceeding. It is by no means certain to produce a plant. But combined with strong growing grasses there is less risk, and the grasses keep down weeds and prevent the growth of couch and other pests which almost invariably overrun a pure Sainfoin ley after the first two years.

In the green state Sainfoin is quite free from the danger of blowing cattle, and when made into hay it is an admirable and nutritious food. But the making of Sainfoin hay is rather a ticklish business, particularly in catching weather. Like *Trifolium*, the plant has a hollow stem, and when cut it is more quickly deteriorated by wet than any of the clovers.

There are two varieties, the common, and the giant or double cut, the latter being the earlier and more rapid-growing of the two, but decidedly less durable.

CARUM PETROSELINUM, or PETROSELINUM SATIVUM

(*Sheep's Parsley*).

This plant is frequently included in mixtures of grasses for uplands and sheep downs. Sheep manifest a great fondness for the herbage, which has been said to be a preventive of rot and red-water in that animal. Hares will visit gardens for the sake of the Parsley grown in them, and where this game is abundant it may be worth while to sow patches in the covers. The seed germinates so slowly that six or seven weeks may elapse before a plant is visible.

SOWING GRASS SEEDS.

THE actual work of sowing grasses is simplicity itself, but as the germination of the seed and the equal distribution of the plant depend upon the accuracy of the process, the details should be carried out with due regard to the serious loss which failure certainly entails. The necessity for making the seed-bed fine and firm has already been enforced. At sowing time the additional requirement is a soil dry enough to allow the implements to work freely without any tendency to gather in clods on the roller. I know that waiting to sow will often tax the patience severely. But it is worse than useless to enter into a conflict with Nature. All such conflicts inevitably end in the defeat of man.

The first business is to run the harrow over the land to prepare it for the seed, and the sowing may be either performed by hand or by means of the common seed-barrow. Some men are skilful in spreading seeds equally by hand, and on a still day their work answers well. But grass seeds are light, and it does not need a very high wind to make the sowing irregular. As the barrow delivers the seed nearer to the ground, it will, as a rule, distribute the grasses more evenly than the most practised sower by hand. But whichever method is adopted, there is a decided advantage in making two sowings. If the grasses and clovers are mixed together, half the quantity should be sown by passing up and down the land, and the other half by crossing the first sowing at right angles. When the grasses and clovers are separate, the grasses can be put in one way, and the clovers should cross them.

A bush-harrow is the best implement for covering the seeds. In its absence a light iron harrow will answer, and the lighter it is the better. What is wanted is that as many seeds as possible shall be just covered with soil, and no more. Grass seeds will germinate and become established when they are merely pressed upon the surface of the earth, provided that they are not consumed by birds or scorched under a hot sun. But many will not germinate at all at a greater depth than half an inch. Hence the necessity of a fine soil and shallow sowing.

The roller must promptly follow the harrow, and it makes a better and more certain finish to go over the ground twice in different directions with a roller of moderate weight than to accomplish the task at one stroke with a heavier implement. The importance of this part of the work will be made apparent if any spots are missed by the roller, for on those spots there will be no grass plants.

A specially good plant may often be obtained by first rolling with the Cambridge or ring roller, then sowing the seed, and afterwards crossing the land once or twice with the ordinary smooth roller.

Hard and fast rules cannot be laid down as to the time for sowing. In a great measure it depends on the weather, and perhaps the easiest way of arriving at a conclusion will be to consider separately the relative merits of spring and autumn sowing.

Spring Sowing.—The term ‘spring sowing’ is here intended to apply to the months of March, April, and May. And as a rule it is better to sow early than late. In the early spring the soil is always damp enough to keep the plants growing after they have made a start. But as the season advances the state of the ground becomes increasingly critical in this respect, and there is serious risk that it may not be sufficiently moist to maintain the grasses until the next rainfall. Then follows the extreme mortification of seeing a promising plant gradually wither away.

April is properly regarded as a very safe and favourable month in which to sow, but if the seed-bed is ready, and the land in working order by the middle of March, there need be no scruple as to putting in the seed. And should there happen to be signs of approaching rain, it is worth any reasonable effort to get the sowing done and the land rolled down before a change of weather can put a stop to operations. Sowing before is better than immediately after a shower, even supposing the land can be worked soon after rainfall, which may or may not be the case. The seeds sown before rain gradually absorb moisture from soil and dew until wet weather comes, and then the plants spring up with great rapidity.

To sow later than the end of May is most hazardous. Even the middle of May will often be too late, especially upon heavy soils, which in a dry season are also liable to crack, to the injury of the grasses.

Now comes the question as to sowing alone or upon a corn crop. The answer depends partly on the object in view, and partly on the length of the purse. Apart from the money consideration, each method has its advocates, and undoubtedly there are sound reasons to be urged in favour of either practice.

If a first-class pasture or an ornamental park sward be wanted on the earliest day it can be obtained, and the cost need not be thought of, the sowing of grasses alone will, in the majority of seasons, produce the most satisfactory pasture in the shortest possible time. Opportunity is thus afforded of early and frequent mowing, which tends to strengthen the young grass. A still more valuable service is rendered by the scythe in preventing weeds from seeding, and these are certain to be quite troublesome enough without that. On the other hand, in an extremely dry summer, the shelter of a light corn crop will prove of great value to the young grass plant. It may even result in an actual gain of time. Without its aid there is a possibility that the grasses may stand still or completely fade away. An established pasture when burned brown by the sun speedily recovers

its verdure after rain, but young grasses cannot endure so fiery an ordeal.

The assistance rendered in checking weeds is another benefit derived from a corn crop. To appreciate its value, compare one of the finer grasses with some weed growing near, and then say whether the delicate stripling has any chance of resisting its masterful neighbour. Of course the annual weeds will die out by-and-by, but in the meantime almost every one of them will destroy some grass plants. It follows that the more abundant the weeds the thinner will be the pasture, and until the grasses tiller out and cover the ground the crop will be proportionately small. Unfortunately, too, both drought and weeds prove more injurious to the smaller than to the coarser grasses. The fact that corn assists in the battle against both foes is quite sufficient to account for the very general practice of sowing permanent grass seeds with a corn crop. Still it must be admitted that corn does not keep down weeds so effectually as the constant use of the scythe over land that has been sown with grass seeds alone.

Upon the pecuniary value of the corn it is needless to dwell. The point is too important to escape attention, and, as a rule, this consideration is alone sufficient to determine the question in favour of corn, even were the grasses pretty certain to suffer, which happily is not the case.

Of course a corn crop will levy the usual tax upon the land, and it should be clearly understood that the grasses are not to sustain the loss. A liberal top-dressing of cake-fed manure must be applied after the corn is cut, to compensate the grass for what the corn has taken away.

One point is of utmost consequence if corn is not to injure the coming pasture, and this is the necessity of a very light seeding of corn. A heavy crop is harmful in itself, and involves further danger when it becomes laid. On the spots where a heavy crop is lodged the grass will almost certainly be killed outright, and the slight additional gain derived from a full seeding of corn will

be more than counterbalanced by losses in the grass plant, to say nothing of the labour of patching it afterwards.

The time for sowing grass seeds with spring corn will be either immediately after the corn is got in, or when it is only two or three inches high. It is well understood that the less forward the cereal, the better the chance for the grass.

On heavy, and especially on rich land, the choice of corn is open. It may be either barley, oats, or wheat, and wheat is always desirable for the grass.¹ For lighter soils barley or oats are available, and in this case oats are preferable to barley. Broadcasting the corn is more suitable than drilling, as the cereal and the grasses then come evenly and cover the soil.

Under certain conditions it answers well to cut the oats green, and turn the crop into hay or silage. This method of treating the herbage helps to keep down weeds quite as much as when the oats are allowed to mature, and it takes far less out of the land.²

Occasionally a field in autumn wheat is wanted for a permanent pasture, and there is no difficulty if the land be clean enough, and the grass seeds can be sown before the wheat is too high. In favourable weather the seeds may be put in even as early as the middle of February, as the corn will defend the young grass from injury by frost. Should the wheat be very backward, however, or stand thin on the ground, the sowing had better be deferred for a time. In the event of the

¹ I have been most successful from an April sowing on a thin plant of wheat, and Mr. Clare Sewell Read says: 'I never find any difficulty in obtaining a plant of seeds, even in May, when sown with wheat, for then the ground is firm and the surface soil very fine. Often when the seeds fail in barley, the headlands round by the gates have a good plant, because there is fine mould on the surface and a solid bottom.'

² A well-known Scotch agriculturist says that he 'considers the best method of sowing to be with about two bushels of oats, to be cut green before there is any kernel. There is a large crop of useful fodder, the small seeds have beneficial protection while they require it, annual weeds are kept down, and the grasses get relief by the early cutting at the stage most suitable for them to have full possession of the soil.' He adds: 'I have sown down one hundred and sixteen acres in this way. The same grasses, sown at the same time and sometimes on parts of the same field, but with the oats allowed to ripen, have proved decidedly inferior.'

land being at all foul, hand-hoeing must be resorted to, and this will open the ground for the grass seeds. The necessary harrowing and rolling will be beneficial to the wheat plant.

Notwithstanding all that has been said in favour of sowing rape with grass seeds, I cannot recommend the practice. Instances can doubtless be cited where no injury has resulted. But the great objection remains that rape necessitates feeding off the crop by sheep, and, when the rape is ready, the grasses rarely have sufficient hold upon the ground to bear grazing with impunity. The animals eat the hearts out of some plants, pull up many more, and altogether do a lot of harm to a young pasture.

Autumn Sowing.—Many writers have vexed their souls over the relative merits of spring and autumn sowing without advancing any nearer to a solution of the problem. It cannot be solved at all by generalities, although the attempt has often been made. For practical ends it may be disposed of here by accepting necessity as a guide, and then perhaps there need be little or no controversy about it. The decision largely depends upon the possibility of working heavy land in a wet spring. Sometimes autumn sowing is resorted to when a hot dry summer has scorched the life out of a spring plant. This is one of the many misfortunes to which the agriculturist is liable, but it does not touch the point now under consideration.

Were all the land of the United Kingdom light, probably the question would never have arisen. There would have been a general consensus of opinion in favour of spring sowing. It is the extreme difficulty of making heavy land ready for grass seeds before the spring is too much advanced, which renders the state of the weather of so much more importance when sowing grasses than when sowing any other seed. Sometimes it is absolutely impossible to thoroughly pulverise a tenacious soil until May is far gone, and then it is very risky indeed to put in grass seeds. Thus an autumn sowing becomes imperative.

Having reached this conclusion, it is satisfactory to remember that in addition to the chance it affords of making a thoroughly sound seed-bed, the temperature of the land in autumn is highly favourable to the germination of grass seeds, particularly in the North of England. Further benefit is to be derived from the clearing of successive crops of annual weeds, most of which would have appeared among the grasses of an earlier sowing.

The danger of an autumn sowing mainly concerns the clovers. Young grasses, especially of the coarser varieties, will stand much winter cold with impunity. Not so the clovers, although when established they also will endure severe weather unharmed. But while young, a wet cold winter will almost certainly make an end of them. A retentive soil will foster a magnificent pasture containing plenty of clovers when once the plants are established, and yet on such soils it will frequently prove most difficult to establish clovers from a sowing of seed in autumn.

As to the best month for autumn sowing, it must not be forgotten that grass seeds are peculiarly liable to be 'malted' under a burning sun when the ground is not moist enough to keep the plants going. A slight thunder shower upon a dry soil, followed by scorching sunshine, is quite sufficient to do the mischief, and many failures of autumn- as well as of spring-sown seeds are attributable to this cause alone. Even when the failure is not total, it is a serious matter if the finer grasses are killed and only the coarser varieties survive. For it is very difficult to establish the finer grasses after the stronger varieties have had a six months' start. As a consequence the pasture may always be inferior in quality.

Supposing, however, that the soil is not too dry, and is otherwise in good condition, sowing in August is to be commended, and the earlier the better. The plants will then have a chance of becoming fairly established before winter sets in. The first week in September is, in most seasons, the latest date at which a

permanent pasture can be laid down with any reasonable hope of a satisfactory result, except in the extreme south.

I have formed a good grass layer by sowing in autumn with winter oats, and the grass came so forward as to be fit to carry stock in September of the succeeding year.

Every field sown in autumn should undergo a searching examination in the following spring. If it is evident that the clovers and finer grasses have failed, more seed of the missing sorts should be sown before the grasses become too strong. There need be no anxiety as to the effects of spring frosts, for the grasses will afford the young clovers friendly and effectual shelter.

THE
IMMEDIATE AFTER-MANAGEMENT
OF NEW PASTURES.

A SPRING sowing of grasses is made at a time when atmospheric changes are sudden and severe, and grass seeds are not so well constituted for resisting these violent changes as corn and other heavy seeds. Besides, the spring is never so dry and cold as to prevent the growth of weeds, nor is the May sun hot enough to scorch them to death; but after sowing, a long spell of unfavourable weather will seriously retard the grasses. Meanwhile the ground may be covered with chickweed, groundsel,¹ and other weeds. As these extend, the chances of the grasses diminish, until at length it is possible that only a few spots will be found on which they show sufficiently to prove that there would have been a crop had circumstances been favourable. In a backward spring early sowing increases the danger of the grasses being smothered by weeds.

But if early sowing has its perils, late sowing is not free from them. From the former arises the possibility that the young grasses will be injured by weeds, and from the latter that before the grasses are sufficiently established to endure great heat, they may be scorched beyond recovery by fierce sunshine. Or the soil may be so dry that the germination of the seed is dependent on rain, and if only a brief shower falls, the seeds

¹ Groundsel will actually flower when the thermometer stands near the freezing point. Humboldt observed the plant growing in the upper reaches of the Andes, just below the region of eternal snow, where the sun had little power and where hurricanes are incessant and not a tree is able to rear its head.

will start. Then should there come the dry blast of an east wind, or burning drought, every seedling will perish.

I am not conjuring up difficulties for the sake of saying 'There is a lion in the way,' but rather to show that for so important and costly an undertaking as laying down land to grass there is absolute necessity for insisting on the cleanest possible seed-bed. Even when the farmer has done his utmost to clean the land, plenty of weeds will spring up in the soil. It is then a question of precedence. If the grasses come quickly, the annual weeds do little harm when promptly checked, but if the weeds obtain a strong lead the injury to the grasses may prove serious, perhaps entirely destructive. Happily the majority of seasons favour the sower, but that does not relieve him from the necessity of taking every reasonable precaution to ensure success under what may prove to be very adverse influences. Possibilities must be considered, and by being forearmed the probability of success may be considerably enhanced.

It is in the immediate after-management of newly-sown grass that the advantages of dispensing with a corn crop are realised. Nothing can be done to help grasses sown in corn until the crop is cut and carried, but when grass is sown alone it is possible to top the plant as soon as it is a few inches high with a sharp scythe, and the benefit will speedily be visible. After mowing, the roller should be put over the land again, which will help still further to consolidate it, and to give the young plants a firm grip of the soil. The more frequently the pasture is mown and rolled during summer, the more rapidly will the ground be clothed with verdure. By August or September, in a favourable season, the grass may be allowed to grow on to produce a small lattermath hay crop, after which it will carry horned stock, eating cake, through the autumn.

Although constant mowing will get rid of groundsel and other annual weeds, it will be powerless against such pests as docks and coltsfoot. These can only be removed by a spud or narrow hand-hoe, and for the sake of the future of the pasture it is

well worth while to give these strong growing weeds early and persistent attention. Thistles can be eradicated by repeatedly chopping them off near to the ground with an old scythe until they bleed to death.

Should it be found by the middle of May that the plant has failed, not a moment must be lost in shallow-ploughing or cultivating the land, breaking it down again into fine tilth, and re-sowing. Supposing, however, that the seed has taken over the main area, leaving some bare spots, these must have their crust broken with a hoe, followed by a heavy rake, and be re-sown, raked over, and again rolled down. When the plots which have missed plant are too large for hand work, the harrow can be employed instead of the hoe and rake. It will never do to assume that the crop is all right. Rather assume that it is not perfect until examination has shown the contrary.

For grasses and clovers sown with corn only one thing can be done until the corn is cut, and this is to go over the ground to remove thistles, &c. It is always worth doing on a corn crop alone, but, when grasses are there also, the operation becomes imperative. Immediately the corn is off the ground the whole field should be carefully examined to ascertain whether there is a plant or not. After a wet harvest there will be no difficulty in deciding promptly. But in a dry season I do not advocate a hasty judgment. The dry stubble, the parched ground, and the brown herbage all help to mislead. A few hours of warm soaking rain may put a new complexion on an old face in so brief a time as to produce an almost magical effect, and therefore it is not wise to be in too great a hurry to pronounce upon success or failure. I know an instance where a spring sowing of permanent grasses was followed by a dry summer, and when the corn was cut no plant at all was visible. A top-dressing of four hundredweight per acre of bones and superphosphate was applied with such good effect that in the following summer a heavy crop of hay was cut.

If the plant is evidently all right, there can be no doubt that

it will abundantly pay to give a top-dressing of farm-yard manure, or some good artificial, to help the young grass into vigorous growth. Bare spots caused by the laying of the corn or from any other agency must be lightly broken, sown, and rolled down again. It will be quite necessary to look these patches over in the following spring to see that they have passed safely through the winter, otherwise they must be sown once more.

Should the failure be total, it will generally be impossible to smash a hard stubble, and get it clean, fine, and firm by the first or second week of September; and therefore it is usual to defer re-sowing until the following spring. On two or three occasions I have risked sowing grass seeds on a stubble, after the manner common with trifolium. In each case the stubble was unusually clean, and, directly the corn was carried, a heavy drag was put over the land and the seed was bushed in. The success was very marked indeed, but I do not feel justified in drawing large inferences from a few experiments of this kind.

After a corn crop the pasture sown with corn will not be in the same condition for grazing as when grasses are sown alone. The care and attention which can be devoted to the latter during summer make all the difference. I know that horned stock are sometimes turned on to the former after a dripping summer. But if there are occasional instances when cattle may be put on to a stubble containing young grass without inflicting injury, there can be no doubt whatever about the folly of permitting sheep to graze it. They bite extremely close, and with a snatching movement which uproots an immense number of the young plants that have not sufficient hold to bear the strain. Another fact is worth consideration. Both cattle and sheep, if allowed to graze too soon, are apt to pick out certain grasses and clovers for which they have a partiality, leaving others to seed or to develop into ugly tufts. Whenever this happens it is wise to let a man go over the ground two or three times, and cut these tufts down. The new growth will afterwards be eaten close.

In the early management of autumn-sown grasses, the object

to be kept constantly in view is the promotion of free growth before winter sets in. Topping the young grass with the scythe and rolling will prove advantageous to the plants in helping them to cover the ground and become firmly rooted. Immediately the growth begins in spring mow once more, and a final rolling is also essential. After an autumn sowing it is especially necessary to cut the hay crop very early. When it is carried, cattle may be turned in to graze, but sheep had better be kept off until the following year.

Several of the finer grasses, if permitted to seed in a young state, are so weakened that they die, and they appear to perish more readily on some soils than they do on others. This does not show that such grasses should be excluded from a prescription for a permanent pasture as some writers affirm. It would be just as reasonable to say that because certain varieties which revel in a dry soil disappear after a succession of wet summers, therefore they ought to be omitted. A pasture is laid down that it may yield nutritious herbage, not that seed may be saved from it. Grasses which require three or four years to attain maturity, and there are varieties which do not reach their highest vigour in less time, must of necessity be weakened or destroyed by producing seed in the first or second year after sowing, just as animals are permanently stunted by allowing them to reproduce their species at too early an age.

The opinion is widely entertained that the critical period of a pasture is the third or fourth year after it has been sown. But if a pasture begins to fail about that time, it is probably attributable to mismanagement and starvation. No farmer supposes for a moment that he can for several years in succession take much off arable land and put nothing on it. Yet this is a very common delusion concerning grass land. And I say most emphatically that the man who thinks it reasonable to treat either a new or an old pasture on that principle deserves to find it deteriorate in quantity and in quality too. Liberties of this kind are sometimes taken with a rich old pasture, and the injury may

not at once be apparent ; but it is most unreasonable to expect that a young pasture will become established under the starving system and at the same time yield heavy crops.

One cause of the early deterioration of some new pastures is no doubt traceable to grave faults in the prescription of the grasses sown. Too many farmers are content if they can only see 'something green,' without bestowing a thought as to whether the 'something' is good or bad. So long as men will only pay about half the value of a first-class prescription of permanent grasses and clovers, I suppose dealers will be found who are prepared to supply so-called permanent mixtures consisting mainly of annual varieties of Rye Grass, Yorkshire Fog, Tussock Grass, and other cheap seeds utterly unsuitable for the purpose.

In a subsequent chapter reference is made to feeding an old pasture by supplying the animals upon it with cake, and there is no better means of enriching the land. But if the plant cannot be safely fed off until about eighteen months after sowing, obviously some other means of stimulating the pasture must be adopted, and this is why I strongly advise a top-dressing of farm-yard manure after corn is carried, or an application of artificial manure in spring.

The Rothamstead and my own experiments at Kidmore have demonstrated a fact which I am anxious to emphasise. After every care has been exercised in selecting suitable grasses and clovers and a plant has been established, the herbage of any piece of grass will eventually depend on the after-management. If a field which has been judiciously sown be divided into several portions, and each portion is subjected to distinct and continuous treatment for several successive years, a decided difference in the herbage of the several parts will become manifest. Certain manures encourage the growth of certain grasses, and indirectly effect the destruction of those species which are not benefited, by enabling stronger neighbours to choke them. Only those who have carefully observed the results obtained in Sir J. B. Lawes's experi-

mental grass plots will adequately realise the importance of applying suitable manures, not merely for the purpose of augmenting the crop, but as a means of maintaining or destroying some of the grasses.

But manuring is not the only way of effecting changes in the character of a plant of grass. Some varieties are specially adapted for grazing, others for making into hay. A fine old pasture which has been fed for many years will often yield a miserable crop of hay, and may be utterly ruined by being mown for several consecutive seasons. Conversely, a meadow which has been mown for years and kept in condition by annual top-dressings may prove altogether unsatisfactory as a pasture. Grazing gives all varieties of grasses, except a few which will not bear treading, a full chance of existence; while haying fosters the growth of those grasses which come to maturity at a particular period of the year. Some of the most valuable pasture grasses are often entirely absent from good old meadow land. It is therefore desirable as far as possible to reserve meadow land exclusively for mowing, and pasture land for grazing.

On the following page is a statement showing the weights of hay obtained from a young pasture under different manures in successive seasons.

EXTRACT FROM A REPORT ON THE KIDMORE EXPERIMENTS WITH MANURES ON GRASS LANDS.

By MARTIN J. SUTTON.*

(SERIES B. YOUNG PASTURE. 1886-1890.)

THE SUMMER HAY-WEIGHTS.

No.	No. of Plot, and Nature of Manure	Cost of Manure per Acre £ s. d.	1886	1887	1888	1889	1890
			Tons cwts. qrs.	Tons cwts. qrs.	Tons cwts. qrs.	Tons cwts. qrs.	Tons cwts. qrs.
No. 1.	Unmanured	—	1 11 3 Manured	1 13 0 Not Manured	1 7 0 Manured	1 8 1½ Not Manured	1 9 3¾ Manured
" 2.	1 cwt. Sulphate of Ammonia	0 14 0	2 5 3	1 8 1	1 13 2	1 2 1½	1 5 2¾
" 3.	1½ cwt. Nitrate of Soda	0 16 3	2 10 0	1 9 3	1 15 2¾	1 6 1½	1 11 2
" 4.	3 cwt. Superphosphate of Lime & 2 cwt. Kainit	0 15 9	2 4 2	2 2 0	1 10 3¾	1 8 2¼	1 12 0½
" 5.	1 cwt. Sulphate of Ammonia & 2 cwt. Kainit	1 0 0	2 6 3	1 8 2	1 14 3¼	1 7 1	1 10 0½
" 6.	3 cwt. Superphosphate of Lime, 1 cwt. Nitrate of Soda & 2 cwt. Kainit	1 8 9	2 11 3	1 14 0	1 14 1½	1 7 1¾	1 12 0½
" 7.	4 cwt. Basic Cinder, 1 cwt. Nitrate of Soda & 2 cwt. Kainit	1 1 3	Experiments 7 to 18 were not commenced until a year later than Experiments 1 to 6	Manured 2 0 2	Not Manured 1 5 2¾	Manured 1 17 3¾	Not Manured 1 10 0½
" 8.	10 tons Farm-yard Manure	3 0 0		1 17 2	1 14 3¼	1 14 2½	1 4 3
" 9.	5 cwt. Decorticated Cotton Cake	1 15 0		1 19 1	1 4 1¼	1 15 2	1 9 0
" 10.	3 cwt. Peruvian Guano	1 1 9		1 16 3	1 3 1½	1 16 1½	1 2 1¼
" 11.	Unmanured	—		1 6 1	1 1 0¾	1 6 3¼	0 19 1¼
" 12.	4 cwt. Basic Cinder & 2 cwt. Kainit	0 10 6		1 14 0	1 6 1	1 12 1½	1 4 3
" 13.	4 cwt. Ground Coprolites & 2 cwt. Kainit	0 16 6		1 17 0	1 4 2¼	1 12 0½	0 18 3
" 14.	10 cwt. Gypsum	0 15 0		1 8 2	1 4 3	1 11 2	0 16 1½
" 15.	1 cwt. Nitrate of Soda & ¾ cwt. Muriate of Potash	0 17 6	Experiments 1 to 6	2 4 3	1 13 0½	1 19 3	1 13 0½
" 16.	3 cwt. Dissolved Bones	0 18 0		2 4 3	1 14 1½	1 18 1½	1 14 2½
" 17.	3 cwt. Boiled Bones	0 18 0		1 15 1	1 8 3¼	1 11 3¾	1 13 2
" 18.	3 cwt. Raw Bone Meal	0 17 3		1 19 0	1 7 2¾	1 11 1	1 11 3¾

* *Experiments with Manures on Permanent and Temporary Pastures at Kidmore, Oxfordshire, by Martin J. Sutton.*
(London: Simpkin, Marshall, Hamilton, Kent & Co., Limited.)

THE
MANAGEMENT AND IMPROVEMENT
OF OLD GRASS LAND.

IN 1872 there appeared in the Royal Agricultural Society's Journal an account by Mr. R. H. Thompson of a personal inspection of the grass lands of England and Ireland. His laborious journey included visits to the most famous grazing districts, and it was undertaken when farmers were at the height of their prosperity. The following are his conclusions :—

- ‘ 1st. That although very excellent management is to be met with in parts of our best grazing districts in Leicestershire, Northamptonshire, Gloucestershire, Somersetshire, and several other counties, this must be considered quite exceptional, and the treatment of the bulk of the grass lands of the country is very unsatisfactory.
- ‘ 2nd. That our grass lands, if properly managed, would be easily able to meet the demand made upon them for an increased production of meat, even if the supply required were greatly in excess of the present rate of consumption.
- ‘ 3rd. That money judiciously laid out in improving grass land makes a better return than money laid out on arable land.’

These remarkable statements are as worthy of profound attention from those who possess old pastures, as from those who contemplate laying away arable land to grass. Unfortunately,

the grass lands of this country are now in a much more deplorable condition than they were at the time Mr. Thompson wrote. There is not the least exaggeration in saying that at the present moment thousands of low-lying meadows and upland pastures are not yielding half the produce which could be obtained from the land were it in better heart. These pastures grow inferior hay and little of it, the production of milk is restricted, and the capacity for fattening stock is diminished. The result is an enormous national loss, and the truth must be told that this loss is almost entirely avoidable. The prime cause is negligence, begotten of the mistaken notion that a pasture is self-supporting. There is a very general assumption that the owners and occupiers of grass lands are not only relieved from the anxiety and expense of arable tillage, but that they are under little or no obligation to make any return to the soil for all that may be taken from it in the form of hay, milk, or meat. I propose to specify some of the influences which have reduced many English pastures to their present unsatisfactory state, and to suggest means of restoring them to fertility.

One of the principal causes is the practice of taking hay crops for several successive years without giving any adequate return in manure. The necessity for treating arable land liberally is never disputed for a moment. Yet the arable land has the advantage of being constantly broken up and enriched by rain, air, and other of Nature's fertilising agencies; while a pasture is, by its fixed condition, debarred from the benefit of all cultural operations, except the use of the harrow and roller. If properly drained, grass land can generally be maintained in the full tide of fertility by judicious manuring alone, but this is often negligently or wilfully withheld.

The prevalent idea that continuous haymaking is inimical to the welfare of a meadow is entirely illusory, and probably arises from neglect in giving any return to the land for the crops taken from it. Of course the hayrick can be made the instrument of impoverishing grass land more quickly than can overstocking; still

it is not so much the cutting of a meadow which is injurious, but withholding the top-dressing of manure or compost which all mown grass should annually receive.

Again, immense damage is done to some pastures by cutting the crops for hay very late in the season. Many of the grasses have time to form and ripen their seeds, and nothing exhausts plants so much. Some of the finer grasses cannot safely be taxed in this way. They may endure the ordeal once or twice, but if the drain on their resources is frequently repeated they gradually dwindle away. So long as these grasses are mown early, or grazed, they are perfectly perennial, as is conclusively proved by their continued existence in some of the finest old pastures of the kingdom where they have never been allowed to seed. To manage any pasture or meadow in such a way as to exterminate some of its most valuable and nutritious grasses is surely killing the goose which lays the golden egg. And this is exactly what is done by constant greed for the rick. Of course an early crop means a smaller bulk of hay, but unless the turf is exceptional in character the quality is higher than from a later cutting,¹ and the loss of bulk in the first instance results in a net gain, for the aftermath will be the greater, and the pasture will not be damaged for future seasons. Where grasses perish, the gaps are almost certain to be filled up by worthless or noxious forms of vegetation, and thus the herbage diminishes in value so long as a false system of management is pursued.

Another source of injury to pastures arises from the manner

¹ Warrington gives the following analyses, made in each case after the fodder had been dried at 212° F., to show the comparative feeding value of three crops of grass taken from the same field at different dates. The first cutting was made when the herbage was fit for feeding off, the second at the time the crop was in good condition for hay, and the third when it was past its prime, and had become somewhat coarse and long in stem, but still was well harvested.

Date of Cutting	Albuminoids	Fat	Soluble Carbo-hydrates	Fibre	Ash
May 14	17.65	3.19	40.86	22.97	15.33
June 9	11.16	2.74	43.27	34.88	7.95
June 26	8.46	2.71	43.34	38.15	7.34

in which grazing is conducted. It should not be necessary to repeat so trite a remark as that land is never enriched by the droppings of cattle fed exclusively upon its herbage, but, on the contrary, must by degrees become the poorer for supporting the lives and increasing the weight of the animals which graze upon it. In milk and flesh the land yields its produce in highly concentrated forms, and without external aid the process of exhaustion must of necessity go on. But when the herbage consumed is supplemented with cake, corn, roots, hay, or other extraneous food, benefit is conferred on the pasture in addition to the advantage which the animals derive from it. The improvement will, of course, be gradual, and its progress be regulated by the quantity and the quality of the additional food supplied. In this extra feeding of grazing animals there is a simple and economical means of enriching a poor pasture, and the increased weight of the stock is an immediate if only a partial return of the outlay. Agricultural chemists tell us, and their analyses are supported by experience, that animals only assimilate one-tenth of the nutritious qualities of cake or other highly concentrated feeding stuffs, and that the remaining nine-tenths, after passing through the cattle, are available for vegetation, in a form specially adapted to meet the requirements of plant life. This explains the marked improvement which is always observable when grass is depastured by cake-fed cattle—an improvement superior to that effected by a dressing of farm-yard manure, because none of the valuable elements are lost by fermentation. And this fact suggests the economical aspect of the practice. The carting of heavy bulks of manure is avoided, and the land at once has the benefit of the droppings. When manure is stacked in heaps, or is allowed to lie in the farm-yard, some of its most fertilising constituents drain away or are dissipated in the atmosphere. It will also be evident that to graze a pasture by day and fold on the arable at night is a very ingenious device for ruining grass land. Even when sheep are helped with cake it is no sufficient compensation for their absence during twelve out of the twenty-four hours.

A further means of deteriorating grass land is the practice of allowing pastures reserved especially for horned cattle to be overstocked. When an ox-pasture is eaten down so bare as to allow the roots of the more succulent grasses to become scorched, it is a serious injury not only for that year's feed but for several subsequent seasons. In one of the recent hot summers I hoped by a liberal allowance of cake to make a pasture carry more stock than the crop justified, and the result was disastrous to the plant. On the other hand, an established sheep pasture cannot well be cropped too close to maintain constant growth of the sweet fine herbage of which it should consist.

Wide-spread indifference prevails as to the predominance of such weeds as cowslips, primroses, orchids, daisies, and plantains, although these plants frequently show that the soil is in such a condition as to be incapable of maintaining nourishing herbage. The mere presence of these weeds and of barley and brome grasses is an evil in itself, and they indicate that the land is starved, just as tussock grass, rushes, and sedges prove the need of drainage. Thistles, docks, coltsfoot, and other large weeds may also abound, and they cannot be eradicated without the constant use of the scythe and spud. In a foul pasture the weeds are generally so mixed up with what good herbage there may be, that they can only be improved out of existence as better grasses are induced to take their places. A heavy dressing of salt applied after weeds have been cut will kill a lot of them, and an application of gas-lime has been known to effect a surprising change in the herbage of an inferior pasture. The folding of sheep thickly will also produce marked benefit on poor upland grass if the animals are at the same time fed with corn or cake. They should be penned on the ground long enough to make it as brown as a fallow, and then many weeds will be killed outright. This practice is very different in its effects from that of giving sheep the run of the land. Whatever discourages the growth of rough herbage encourages that which is better. On the other

hand, however good a pasture may be, it has only to be treated with a policy of masterly inactivity, and in time it will revert to the waste condition of a moorland.

A succession of wet summers is another fruitful source of injury to pastures. The bulk of herbage forced from them during warm damp seasons tends greatly to their impoverishment, and some of the grasses which are more especially adapted for dry soils will probably perish. Well-drained land naturally suffers least. Land not so well drained becomes sour and unwholesome, and only the sedges and coarse water-grasses survive.

Hitherto nothing has been said about seed, and it may be frankly admitted that with liberal management it is quite possible to restore the fertility of a pasture without sowing seed at all. But it will take time, perhaps many years, and it appears to me to be a penny-wise and pound-foolish procedure to occupy a long period in making an improvement which might be effected in a single season at a very trifling outlay beyond that necessarily incurred in carrying out improvements already suggested. In every case where the plant stands thin on the ground I am persuaded that it will pay to bush in a few pounds of the finer grasses and clovers per acre. I am acquainted with a farmer who sows twenty pounds of grass seeds per acre every autumn on an old pasture, because he has found by experience that when he omits doing so there is a difference of a ton of hay per acre in the cut of the following year. The seed may either be sown before the grass starts growth in February, or immediately the hay has been cut in June. February is, however, a very good time. On damp land preparation should be made by an application of salt to the most weedy parts, and a severe dragging over the entire surface. A well-mixed compost of lime, the contents of ditches, and any other available rich material, should be distributed over the whole meadow, and the seeds can be sown on any day when the ground is dry enough to permit the roller to be used. The meadow should then be laid in for hay. And after the crop is cut cattle may be allowed to depasture the

land, but sheep must not be admitted until the following year. Upland pastures may be treated in a similar fashion.

For destroying moss there is no better dressing than two cart-loads of lime mixed with eight cart-loads of light loam per acre: pure lime is too powerful to be applied alone. The heap should be turned several times until the lime is thoroughly slaked and well incorporated with the loam. After dragging the turf with heavy iron harrows, ten cart-loads of the compost should be spread over each acre. There will soon be a marked improvement, and a full return for the outlay.

The effect of dragging a pasture is not everywhere appreciated at its full value. The mechanical action breaks up the congested surface, allows the atmosphere to penetrate to the roots, and thus promotes a free and healthy growth of the plants. It also enables the grasses to absorb and derive benefit from any fertilising agent or compost which may be applied to the surface, instead of allowing the dressing to be in great part washed away by the first heavy rain.

HINTS ON HAYMAKING.

A good deal has been written for and against the practice of mowing and grazing alternately. Strictly speaking, meadow land is always mown, and pasture land is always grazed. Both the terms and the practice are now generally regarded as convertible. Yet there is more in the distinction than appears at first sight. Certain grasses are better adapted for the scythe than for being eaten down by stock, and some fields contain a preponderance of one or more of these varieties. A meadow which answers to its strict definition should consist of such grasses as flower almost simultaneously, so that the entire crop may be ready for mowing at one time. Such land will, of necessity, be most unsatisfactory for grazing. There will be no early or late grasses for the cattle, but an overpowering crop in June and July, which cannot be fed off economically. On the other hand, a good pasture containing such grasses as will ensure a continued succession of food yields a poor hay crop. However, the question before us now is not the best means of creating either the one or the other, but the turning into hay of such grass as may have been set apart for that purpose.

The presence of stones, corks, and other hard rubbish which may have been deposited by previous dressings not only diminishes the crop while growing, but will by-and-by make it necessary to set the machine high enough to avoid breakage. Now the mower should always be set as low as possible, for the bottom herbage is, weight for weight, always more valuable than the top, and every inch of the former counts both in weight

and in quality. The clearing of stones from the field is therefore worth scrupulous attention, and it should be done before the grass makes a start in early spring. The turf must also be well bush-harrowed and firmly rolled down.

The time for mowing varies in different localities and in different seasons. But there are sound reasons for urging the importance of cutting the grass young, before even the earliest varieties have formed seeds in their flower-heads. In most grasses, and in all clovers, the secretion of saccharine matter occurs in their stems during the early stage of growth, and the best hay is usually made from grass before the flowering heads have begun to turn colour. Experiments made in the chemical laboratory prove that, although there are exceptions, the great majority of grasses contain nearly double the quantity of nutritive matter before, than they do after, ripening seeds. This applies with especial force to the clovers which form so large a proportion of every good pasture. An objection to the early cutting of grass deserves a passing remark. It is quite true that young grass shrinks more than grass of older growth. In other words a larger quantity of moisture is evaporated by the former, but as the loss is pure water only it is of no importance whatever. The balance is in favour of early mowing, for the hay is of higher quality and far more digestible, to say nothing of the advantage of an increased aftermath and the benefit conferred on the pasture by early cutting.

Mowing machines have greatly altered the conditions of haymaking, and the change is not always in favour of the hay. The temptation is to cut more grass than can be dealt with, and in wet seasons this may involve serious loss; for in a scorching time grass becomes hay almost without any making, and it may then be so burnt up before it can be ricked as to render the fibres hard and woody.

The stems of grass are protected by a covering of silica, which has been termed 'Nature's waterproof mantle.' Tossing the grass about breaks the stems. There is a rent in the mantle

by which wet enters and decay is hastened. Hence in continued wet weather the cut grass should be allowed to lie just as it is left by the scythe or mower, and it will then take the minimum of harm. In fine weather the tedding machine should be used much more freely than is commonly the case, for every time the machine goes over the ground a different set of grass stalks are exposed to the sun. Often, when the end of a field is reached, the beginning is ready for a fresh start, and it is a mistake to suppose that because scorched grass makes bad hay, therefore quickly made hay resembles scorched grass. These remarks are intended to apply exclusively to meadow hay. Clovers, Sainfoin, &c., should be turned in the swath by hand, and with utmost care, to avoid breaking off the leaves.

When a particular field is ready, the whole strength of the farm should be concentrated on the labour of gathering and carting the hay to the rick. I have known a crop of grass cut one morning and stacked at night; but the crop was light, the heat unusual, and the desiccation of the plant had considerably advanced before the mower was used. Still, I am persuaded that in hot weather grass might often with advantage be put into windrows or cocks on the day it is cut, although it is seldom done. Dew is well-nigh as injurious to half-made hay as rain, and grass which has parted with much of its water on a hot summer day is in a condition to reabsorb moisture from the atmosphere at night. This process goes on much more rapidly when the hay lies scattered on the ground than when it is cocked. The cocks should not be opened too early in the morning, and if the sun prove hot it will spoil the colour to scatter the grass very much. Greenness is one of the indications of well-made hay, while a brown shade, whether resulting from rain or sunburning, is a certain sign of deteriorated condition. Three days ought to make good hay in fair weather from an ordinary crop. Grass which is cut one day, tedded repeatedly the next, cocked that night, and opened out again on the following morning, may be fit to carry in the afternoon of that—

the third—day. A very heavy crop, however, or a crop in which there is an unusual proportion of clover, must not be ricked so quickly, nor must it be left too thin on the ground. Succulent grass with large solid stems, full of moisture, is least easy to turn into hay, and is most liable to fire when ricked. This danger is often increased by fine weather, because the leaves and smaller shoots become ready to carry before the succulent stems. Those who have had experience with water-meadows are aware of the extreme hazard of carrying hay from them too soon. An old and safe test of fitness is to gather together a few of the stout stems and twist them tightly into a rope. If moisture exudes, the grass is not ready for the rick. Clover stems, Cow Grass especially, also contain a large amount of moisture, and if ricked too soon there is a risk of the heat rising injuriously. The use of the haymaking machine must be avoided entirely when clover forms a large proportion of the crop.

Dry and benty grass which does not contain much clover will almost ‘make itself’ in fine weather, and but little fear need be entertained that it will fire. Indeed, if the rick does not heat somewhat the hay will be of inferior quality.

Ricks may occasionally be seen standing on the bare ground where floods are not unknown. It is unwise to erect them on such spots, for they absorb moisture almost as readily as a lump of sugar placed in water. Some injury will probably ensue from the damp ground, and the whole bulk of hay may be made mouldy by a flood. The cost of stone or iron staddles will often be repaid in a single year, and they render it safe to put hay into a rick much earlier than where this means of bottom ventilation is lacking.

The best shape for a rick is square. A thin oblong form exposes too large a surface to the atmosphere, and a very high-pitched roof is objectionable on the same ground. The bottom of the stack should be smaller than the eaves, so that rain falling from the thatch will clear the sides of the rick. In building, the centre should always be kept higher than the outside, and every layer of grass must be firmly trodden down. The roof must be

steep enough to shoot off rain and snow, but it injures the upper portion of the hay to go higher than is necessary to secure this object. Roughly stated, the top of the rick measured across under the eaves should be about one and a half or two feet more than from the eave to the ridge. This gives almost an equilateral triangle.

A set of rick-cloths cost money, but they are of great service in protecting partially-made ricks when hay-carting is suddenly interrupted by rain. They also make it easy to proceed with several ricks simultaneously, and therefore the grass can be stacked in a more moist condition than when a rick has to be hurried up and promptly thatched. Indeed, rick-cloths save all anxiety about thatching, for the task can be deferred until after the first rise of heat has been dissipated, and it is consequently safe to put the roof on.

The practice of making ventilating shafts in the centre of a rick by pulling up a sackful of hay as the work proceeds need only be resorted to in catching weather, when it is impossible to put the hay together in first-rate order. No doubt the contrivance has prevented many ricks from firing, but it restricts the partial fermentation which takes place in a solid stack, and this is an important influence in the manufacture of a fragrant sample of hay. A much better method of treating grass about the dryness of which there is a doubt, is to place layers of dry straw between thicker layers of hay. The straw will absorb the excessive moisture, and with it many of the valuable juices of the clovers, which will greatly enhance the feeding value. This procedure is not available for hay which is intended to be sold, but it will make capital fodder for home consumption.

‘Weathered’ hay—that is, hay which has been repeatedly soaked and dried until much of its value has been lost—will be improved in quality and made much more palatable to stock by sprinkling coarse salt over the layers of the rick as the building proceeds. From ten to twenty pounds of salt should be used for each ton of hay.

After grass is cut for hay, it parts with nearly three-fourths of its weight by evaporation; but, except under the influence of long-continued rain, no chemical change of importance occurs in the field. In the rick, however, very considerable chemical changes take place, such as the creation of sugar by the action of heat on the starch contained in the grass. The difference between good and bad hay nearly as often results from too little or too great heat being evolved in the stack, as from faults in the process before stacking. Overheating, even when it does not go so far as to blacken and char the hay, produces so much acetic acid as to make the fodder sour and unpalatable. Dr. Thompson showed that $387\frac{1}{2}$ pounds of grass are required to make 100 pounds of hay. The loss is chiefly water, but not entirely so. This is demonstrated by the fact that an animal which thrives on 100 pounds of grass will not do nearly so well on 25 pounds of hay supplemented with 75 pounds of water. The loss of nutritious ingredients is of course attributable to the process of fermentation carried on in the stack. The sugar has been largely converted into alcohol and carbonic acid, by which a certain amount of waste has occurred.

However closely a field may be raked after the hay cart, a quantity of loose hay will remain scattered about, and it will be well worth while to turn in some rough cattle to pick this up, and also to browse on the patches round the headlands and ditches which have escaped the mowing machine. Much waste is incurred by carelessness in this matter, and if the grass by the hedges and ditches is not eaten down while green it will be unsightly all the summer. Immediately the cattle have consumed it they must be driven out of the field, to give the aftermath time to make a fair start.

The making of aftermath hay is not by any means general, and is always precarious. Autumnal dews and shortening days, combined with the succulent nature of the herbage, are all against it. But as many of the late-growing grasses, of which the herbage principally consists, are specially nutritious, there is

a prevalent opinion that the lattermath is of higher quality than the first cut.

The old Welsh system of 'fogging,' or allowing the hay crop to cure itself, uncut, in the open fields, demands but brief notice here, and I cannot speak from personal experience of the practice. It appears to be similar to the method pursued on the Rocky Mountains, but there it is supposed to be possible only at great altitudes. I understand that the fields are fed off by winter stock early in the spring up to the end of April; then the grass is laid in as if for hay, but is left uncut all the summer, and stock are not permitted to graze until December. It is stated that cows feeding on the dry grass give as good butter as in the spring of the year; that the frost makes the grass sweet; and that the herbage shoots very much earlier in the following spring, because it is protected by the brown growth of the previous year; also that when mixed with the old grass it is much more wholesome and sustaining food. The inducement to adopt this system is that all expense and anxiety of haymaking are avoided. Some farmers actually let their grass fields stand untouched from May until February or March of the following year, when the stock are turned out of doors. No doubt the practice supplies a great deal of food at a time of year when it is most scarce, and this food is specially prized for the early-calving cows. The whole system is, of course, contrary to all the recognised canons by which grass land is managed in other parts of the country.

HINTS ON GRAZING.

MOST watchful care is needed to obtain the best results from grazing land, and only those who are actually engaged in the business have any adequate conception of the ceaseless anxiety it involves. Two main objects must be kept steadily in view—the constant progress of the stock, and the maintenance of fertility in the pasture. It may be necessary to change the cattle from field to field, or to alter the relative proportions of sheep and horned stock at very brief intervals. However arduous the labour, the cattle must be kept growing; and the grass be so fed off as to avoid waste and ensure continuous herbage. Allowance has also to be made for differences in seasons. In dry summers what little grass there may be is extremely valuable for its high quality and sustaining power; but when vegetation is rank and sodden with moisture a much larger quantity may fail to put on flesh. Truly ‘the farmer’s eye makes the beast fat.’

No precise date can be given for beginning to graze pastures in spring. Cattle should not be turned out until there is enough feed to keep them going without too much help from hay, nor until the ground is firm enough to prevent their hoofs from damaging the young shoots of the grasses. On the other hand, if the grass gets too old the animals will refuse much of it, and the fodder will be lost. Pastures consisting largely of early, strong-growing grasses, particularly Cocksfoot, will need to be stocked before others which produce finer and later varieties. Even after cattle have made a start, late spring frosts or a persistent east wind may upset the grazier’s calculations, and the stock may

begin to go back through scarcity of food. Then a supply from the mangel clamp, or from a few acres of cabbage or thousand-headed kale, will prove a boon indeed.

When sheep begin to graze in mixed pastures they will probably keep the plant down close; but, as herbage grows more rapidly, young horned stock should be added, so as to feed down the rising culms and flower stalks which the sheep pass by. Sometimes neither sheep nor bullocks will eat the stems of Cocksfoot, and then it is necessary to run the mower over the pasture to prevent a copious seeding of this grass, which, however valuable in suitable proportions, is on certain soils a great pest when allowed to predominate. I have known cattle to derive benefit from grazing in one pasture by day and being turned into a different field at night, and it is interesting to note the eagerness which stock soon display for this change in their run.

A pasture specially adapted for fattening bullocks should not, as a rule, have a sheep upon it; and a perfect sheep pasture should never have the grass long enough to feed a bullock; but from an ordinary pasture, devoted to mixed stock, probably the aggregate produce will not be utilised except by a judicious combination of horned stock, horses, and sheep. The grazier affords clear evidence of his skill by the manner in which he takes advantage of the special characteristics of every separate field as the seasons vary. In so proportioning stock as to feed the crop down evenly he benefits the pasture, and by changing the animals from field to field a difference of diet is ensured, for scarcely any two pastures produce exactly the same herbage. Each animal has its own likes and dislikes, but between them they are pretty sure to clear the crop. Calves need the best grass that can be given them, and they generally thrive better alone than in company with other animals. Cows and sheep feed better together than do fat bullocks and sheep, and this mixture of stock is exceedingly good for the grass. But a first-rate bullock pasture is not certain to be a suitable place for milch

cows, for they are more likely to put on fat than to increase the flow of milk.

As fat beasts approach fitness for the butcher they become very dainty, and will often leave behind a lot of feed. This should be got rid of quickly by crowding the field with store stock. Then a brief rest will prepare it for bullocks again. It is a wise rule to start the stock on the worst pasture of the farm, and gradually move them forward to that which is better. Stock which have once had good food will not take kindly to that which is inferior, but when placed upon it they lose flesh, and this is a ruinous business for the grazier.

No matter how rich a pasture may be, I believe it to be sound practice for the beasts, for the grass, and for the farmer's pocket, to supply a liberal addition of cabbage, mangel, and above all of oil cake, before the feed runs at all short. A good grazier will not be content unless the stock lie down on the pastures a great part of every day. If they cannot quickly satisfy appetite they cannot put on fat, and this is impossible when the animals are wholly dependent on grass which is eaten down close.

After harvest, to give sheep a run on the stubbles will afford a most desirable rest to the pastures, enabling the grass to come on sufficiently to keep the ewes in good condition when put to the ram.

A stringent rule cannot be laid down as to when grazing land should be cleared of cattle for the winter. It should certainly be in time to ensure ample pasturage in the following spring, and the grass must be eaten down close before very cold weather sets in. It is surprising with what relish cattle will take some of the coarse grasses late in autumn which they have refused to eat during summer. Frost no doubt sweetens and makes these coarse tufts palatable. If they are not consumed they must be mown before Christmas.

The necessity of scattering the droppings of cattle is well understood, but it is often neglected nevertheless. By postponing

this work until late in the year a quantity of grass is lost to the grazier. Large unsightly patches of herbage appear, which the animals will not touch. Yet after the grass of these patches is mown and has become withered it is often sought for by animals affected with scour, and it has been stated to have a medicinal effect in curing them. The right thing to do, however, is to have the droppings scattered frequently, and in any case of neglect to have the tufts mown.

A supply of pure water is a matter of great consequence for the animals. It is true they will drink that which is impure, stagnant, and filthy, but it is a vitiated taste, and such water is distinctly injurious to them. Norton's tube wells often prove cheaper and better than the old system of pond-making.

Shade and shelter are also helpful to cattle. Trees and hedgerows save them from fierce sunshine, and ditches should not intervene to prevent access to the shade. Groups of trees in the field not only improve the landscape, but prove beneficial to the animals on scorching days. Rough sheds, open in front and facing south, are desirable in early spring, as they afford protection from biting east winds, and cold, violent rains. In these sheds lumps of rock salt should always be kept within reach of the stock.

ENSILAGE.

(GRASS.)

THE preservation of green fodder, in an undried state, for winter feeding is not a recent discovery. The long and severe winters which prevail in Canada compelled the stock-keepers of that country to adopt the system long before it became familiar to farmers in Great Britain.¹ At first an underground silo, or a special construction above ground, was considered imperative, but it was soon discovered that air could be excluded from forage stored in old barns and outhouses, and ensilage has even been made in casks. It is therefore obvious that costly buildings are not essential, and the erection of them has practically ceased. The silage stack, however, is rapidly increasing in favour. By this contrivance sweet or sour ensilage can be made at will, and the atmosphere can be effectually prevented from injuring more than a few inches of the exterior of the fodder. The stack also offers an advantage over the fixed silo as it can be erected on any spot that will save haulage and facilitate feeding.

Subtropical plants such as Maize and Sorghum are expressly grown for conversion into ensilage, and almost every kind of herbage which this country produces has been experimented upon with more or less satisfactory results. Here I am only concerned with the process in relation to grass, and, so far as its application to this crop is concerned, I am persuaded that the

¹ In so different a climate as that of the islands of the South Seas the natives avail themselves of the principle of the silo for the preservation of bread-fruits.

use of the silo or silage stack will, in favourable seasons, be the exception. Grass will continue to be turned into hay very much as heretofore. Indications point to the subordination of ensilage to hay. When a farmer can convert his grass into hay in three genial days, it is improbable that he will consent to cart nearly four times the weight of green fodder to the silo, with the risk of failure in the end.

Still, it has been clearly demonstrated that in wet summers the silo or silage stack is an immense boon. In districts where the average of seasons is unfavourable to haymaking, ensilage has materially modified the conditions of profitable farming. The reports of greatest success come from farms worked under the alternate system of three or four years' leys. Prescriptions of grasses, clovers, &c., specially adapted for growing suitable herbage for the silo, have produced ensilage of the highest feeding quality.

Lattermath grass may with advantage be sent to the silo or silage stack on account of the difficulty of making hay in autumn, and, as the late crop has the reputation of possessing more 'proof' than the summer cutting, it will be all the more valuable for ensilage.

The cost of labour in making ensilage is not generally higher than the cost of haymaking in ordinary weather, and is decidedly less than the outlay for haymaking in bad weather. In wet seasons, too, the hay is not only more costly to make, but when made is of low feeding quality; so that ensilage in such years will not only be cheaper but superior.

Those who have tried ensilage as food for dairy cows are practically unanimous in its favour, although there is some risk in feeding it alone. In fattening bullocks, however, the Rothamstead experiments prove that for putting on flesh swedes and mangels have a considerable advantage over grass or clover ensilage, whether sweet or sour.

Analyses show that in the process of conversion there is a serious loss in the nutritive qualities of green provender after it is

placed in the silo, yet practical men and agricultural chemists agree that the dietetic value of the food has been clearly established when used in conjunction with hay, corn, and roots, especially for dairy cattle. The animals are benefited in health, the flow of milk is augmented, the colour of the butter improved, and no unpleasant flavour is imparted to it.

BREAKING UP OF OLD GRASS LAND.

SOME pastures are so unproductive and foul with weeds, that in order to secure better crops there is every inducement to break them up, grow turnips or other roots for a year or two, and then sow good permanent grasses and clovers. This is always a serious proceeding; but if, in addition to breaking up the land, there be the additional willingness to brave the cost of paring and burning, I believe the operation may often be worth undertaking, provided the soil is suitable.

A poor mountain pasture, however practicable it may be to ameliorate its condition in other ways, must on no account be destroyed. Paring and burning will almost certainly fail to increase its productiveness, and it is well-nigh impossible to form a sod on such land by artificial means. Nor will burning answer with any light sandy soil. Unless clay is a principal constituent, burning is to be avoided, for it will only do harm. As a rule peats and thin clays resting on chalk are benefited by the process. The colour of the soil generally indicates whether or not burning will be advantageous. A bronzy black soil is fair evidence of the presence of protoxide of iron. Where this chemical compound exists in quantity burning will generally improve the soil, for the protoxide is injurious to vegetation; by the action of fire it becomes a peroxide, which is beneficial to plant-life.

An old and easy mode of discovering whether land will benefit by burning is to place some sods in a large iron pot or kettle, closely covered, and put it over a gentle fire. There must not be enough heat to create a flame. Gradually the sods will

char away to ashes. If the land is suitable, the ashes will be red and powdery, mixed with a few black particles, and when put into water will make it more or less muddy. In the proportion that the water holds the ashes in suspension will the land be benefited by burning. If the land is unsuitable, the ashes will be sandy, and instead of making the water thick they will be precipitated to the bottom, leaving the water almost clear. Supposing this experiment to be in favour of the operation, even then only a small area should be tried until there is conclusive evidence that the proceeding would be advantageous.

There is no necessity to pare the soil deeper than three or four inches, and instead of the spade or turfing iron, a paring plough made for the purpose is to be preferred, especially as it leaves the slice of soil on its edge, so that a drying wind soon fits it for being gathered into heaps. To economise labour, many small fires scattered over the field have been advocated, and undoubtedly they save much carrying of the turf and facilitate the spreading of the ashes. But small heaps are very wasteful. It is almost impossible to prevent them from flaring, and that is ruinous. Large dense masses, however, can be burned slowly and evenly, and at a comparatively low temperature. This point is worth close attention, for it makes an enormous difference in the fertilising value of the ash. The inorganic constituents of the soil are rendered soluble when burnt slowly, and become more insoluble when overburnt.

The effect of burning is to get rid of all the organic matter. But the mineral constituents—with the exception of nitrogen, which plant-life had abstracted from the soil—remain, and they are so transformed by fire as to be easily assimilable by future crops.

The consumption of all the organic matter by fire is of course a destructive process, and in itself involves a considerable loss, but the effect of fire upon the inorganic substances goes far to neutralise this loss. The soil is rendered capable of assimilating ammonia, nitrogen, and other plant foods more

rapidly than before. Fire reduces clay to a friable, disintegrated condition, which readily absorbs fertilising matter. The late Dr. Voelcker conclusively proved this to be the case, and that the effect of heat is to transform some of the mineral elements from an insoluble to a soluble state. For instance, as the soil probably contains various compounds of silicates and of lime, the lime becomes liberated by the heat, and, under the high temperature, attacks the silicates, liberates part of the potash from its insoluble compound, and converts it into soluble plant food. This liberation of potash has probably more to do with the success of burning than any other result consequent upon it. Thus the action of fire effects chemical and physical changes in the soil which are of material advantage to the plant-life which follows. Burning has really very much the same effect, but in a more intense degree, that liming has in sweetening the soil, and in setting free quantities of inorganic matter which were previously in a locked-up condition.¹ An admixture of lime with the ashes greatly augments their value for clay soils. Burning also destroys the noxious forms of vegetation, and the land is freed from bots and grubs, and other destructive larvæ of insects.

It is usual to take at least one crop of roots immediately after burning, and in such a case a mis-plant is rarely known. The ashes absorb so much moisture from the atmosphere, and give it up so slowly, that the turnip seeds have plenty of time to germinate, however great the heat. Even the fly is seldom troublesome on newly-burnt land.

¹ The following is Sir H. Davy's analysis of the ash of burnt turf:—

	Parts
Carbonate of lime	80
Sulphate of lime, or gypsum	11
Charcoal	9
Saline matter, principally sulphate of potash and muriate of magnesia .	3
Oxide of iron	15
Insoluble earthy matter	82
	<hr/> 200

TEMPORARY PASTURES . . . . .	129

ALTHOUGH a large proportion of the cultivated soil of the United Kingdom is perfectly adapted for being laid away to pasture, it is unquestionably true that certain soils do not take kindly to permanent grasses. There are also cases where the absence of fences and the lack of funds to make them, the cultural preparations, and the expense of the seeding, combine to place the creation of a permanent pasture out of the question. In relation to this subject I published a short paper some years ago which had this question for its title: 'Is there no Alternative?' As an answer I ventured strongly to press upon the attention of agriculturists the necessity of adopting the system of alternating grass with corn and roots as a means of enabling them to work with less capital and of reducing the labour bill by at least one-third. Mr. Clare Sewell Read has given the sanction of his high authority to this practice by publicly stating that he considered it to be the only possible way of meeting the present conditions of agriculture.

Several of the reasons why some land will not grow a satisfactory permanent pasture are very ably stated by one of the greatest French agricultural authorities, Monsieur H. Joulie, in his essay on 'Permanent and Temporary Meadows and Pastures,' for which the Société des Agriculteurs de France awarded him a gold medal. He says: 'At first the grass plants find a soil suitably dressed with farm-yard or other manure, that is to say, containing all the elements necessary for their growth. So they grow vigorously. But little by little the soil becomes more compact,

the subsoil more dense, and the rain or water of irrigation penetrates with greater difficulty. During the droughts of summer the moisture rises up less easily from the subsoil, and thus, from physical causes, the production settles down to a normal level. In time the chemical condition of the land also undergoes a material change; not only is the layer of soil which is occupied by the roots rendered incapable of supplying a sufficiently large amount of the elements necessary to the vegetation, but, owing to the continued accumulation of vegetable *débris*, the layer of soil in which the roots live at length becomes sour, even where the earth may originally have been calcareous, and may still be so in the underlying layers, so that the good plants tend to disappear and give place to a vegetation which is characteristic of sour land.'

After giving the reasons and experiments which prove his case, Monsieur Joulie adds: 'From all that has been stated we can now draw the following practical and economical conclusions:—

'1st That the cultivation of roots and cereals deprives the soil of nitrogen, whilst that of grass and leguminous plants, temporary or permanent, on the contrary, causes it to accumulate in the soil. That nitrogen being the most expensive manure to buy, it is not economical to devote part of the land permanently to arable and part to grass, for while the one uses up the nitrogen, the other accumulates it in excess. On the contrary, it is preferable to alternate on the same piece of land the cultivation of roots and cereals with that of grass leys, so as in a measure to repair by the second the loss of nitrogen which the first cause to the soil. By this means cultivation can be kept up indefinitely without purchased nitrogen, provided that the land be maintained in a fit state of richness as regards the mineral elements which are indispensable to healthy vegetation.

'2nd. The practical application of this principle is, that the temporary occupation of the land by a grass ley for two or three years, which takes its turn in the rotation of crops, should be preferred. We thus secure the improvement of the soil obtain-

able from the cultivation of leguminosæ (clover, lucerne, vetches, &c.). But as this class of plant will not succeed on every soil, temporary "leys" with graminaceous (grass) herbage ought to give, where leguminous plants do not succeed, analogous, if not equally good results, and so assist materially in solving the problem of producing cereal, root, and other crops with increasing economy.'

Upon nearly all soils alternate husbandry may be adopted with immense advantage, and on light sandy soil, where a satisfactory pasture is rarely formed, it is far wiser to sow a temporary than a permanent mixture. The periodical breaking-up of the land at the end of every three or four years, and its treatment as arable for one or two seasons, will render it capable of again yielding valuable crops of grass.

The heavy crops that can be obtained from artificial grasses during a limited number of years are only partially attributable to the judicious selection of the grasses and clovers. The chief causes are that the continual use of manure has put the land into good heart, and cultural operations have allowed the atmosphere to set free the elements which grasses readily assimilate. There are, unfortunately, plenty of instances where improper seeding or starved land renders a profitable permanent pasture impossible. To these preventible causes I am not now alluding, but to soils which, in despite of fair treatment, agglomerate and become impervious to atmospheric influences, and refuse to give up the necessary elements for the continuous free growth of grasses.

Apart, however, from this question of an unsuitable soil, there are weighty reasons for the adoption of a system of alternate husbandry. Two-thirds of many farms might with advantage always be in artificial grass. A great saving would be effected in tillage operations, horseflesh, and labour. The land would break up at the end of the term in excellent condition and full of clover roots as a store of nourishment for the succeeding grain crop. The custom of maintaining agricultural holdings that are

almost entirely arable or almost entirely pastoral, has failed to meet the necessities of our time. What is wanted now is a combination of arable and pastoral husbandry, so that when corn does not pay and stock is profitable, or *vice versa*, each occupier may obtain benefit from one branch of his business. The grazier would be profited in being able to winter his own stock instead of selling it to make a winter's manure for the arable farmer. On the other hand, the arable farmer would not then, as now, be compelled to sell his stock immediately his roots were exhausted, or pay the grazier to summer the animals for him. When neither arable nor pastoral land yields a profit, the system I am advocating has the merit of reducing expenses to a minimum.

The specialising of agriculture has been carried to injurious excess. Great arable farms, without enough pasture to keep half-a-dozen cows, and large grazing farms that are wanting in sufficient arable to grow straw and roots for winter consumption, should both be regarded as evils. The admirable system, pursued in Lancashire and in Scotland, of annually laying away in artificial grasses a proportion of each farm for a period of three or four years, is so successful that it is surprising the practice has not long since been adopted all over the country. Instead of this, the sowing of Broad Clover alone is still the rule, and the admixture even of Rye Grass the exception. In comparatively few instances is it usual to sow with the clovers such heavy cropping varieties as Rye Grass, Foxtail, and Timothy, without which the best results cannot be obtained from the alternate system.

The admission of corn into this country without duty, with the present high rate of labour, renders it impossible to grow wheat at a profit on land heavily burdened with rates, taxes, and other charges. Were the price of wheat to rise to a figure that would make it a profitable crop to grow, we could almost, if not entirely, supply ourselves from English soil; but while the doctrines of Free Trade prevail the farmer must turn his atten-

tion to other crops besides wheat, and discontinue flogging the dead horse. The oft-repeated statement that our land is only fit for wheat-growing is erroneous and results in a practice that is economically false. As an alternative, I am fully persuaded that the general adoption of short term leys will prove to be a substantial gain. In itself the system of temporary pastures is good, and a means of good, for it opens up a less ruinous method of farming with a much smaller capital than is sufficient for the conduct of a purely arable farm. It has been said with truth that the immediate return from grass is less than from arable land; and while farmers were paying high rents they could not afford to dispense with a crop like wheat, which could readily be turned into money. This argument takes no account of the continued outlay a wheat crop involves, and which more than absorbs the price the corn fetches. But rents are no longer what they were, even if they ever afforded an excuse for losing the advantage to be derived from temporary pastures.

My late esteemed friend, John Chalmers Morton, published remarks on this subject which are still worthy of attention. He said :—

‘It is honestly believed by many that great loss has come, both to landlords and tenants in England, because they have persistently continued to cherish good hopes of a wheat harvest as year succeeded year.

‘Let us be sure that it is an economical sin to carry on a trade year after year at a loss. We are turning a deaf ear to the teachings of Providence, oft repeated, as long as we continue to attempt to grow wheat on cold and worn-out arable land. It is our old turf that has kept the agriculture of England going for many years past. Much encouragement is held out for a great development in dairy farming and stock production. But meanwhile many of those who actually make a profit in the items of milk and stock throw that profit away. Metaphorically, the mixed farms of our midlands are now pouring their milk down

the furrows. And, we repeat it, all this evil comes because we will "cherish hopes of harvest."

'If some prophet or judge would free us from the slavery of wheat-growing, as the children of Israel were freed from their slavery by Othniel, then the future historian might write of England, "And the land had rest forty years."'

The wide assumption that there is no alternative between corn-growing and the laying down of land to permanent pasture will not bear a moment's examination. The result of this fallacy is fraught with mischief, and entails an enormous loss on the farmers of this country every year. The alternate system offers a remedy of proved value, the adoption of which will tend very materially to turn a deficit into a favourable balance. Cocksfoot, Timothy, Italian Rye Grass, and other strong-growing grasses not only produce heavy crops of nutritious hay, but they smother weeds and keep the land clean; that is, supposing it to have been in a reasonably clean condition when sown. The alternate system will neither justify slovenly preparation nor foul seeding. Those who sow rubbish will assuredly reap as they sow. The seeds sold for leys sometimes consist largely of Goose Grass and Yorkshire Fog with a liberal sprinkling of sorrel and docks. Let no man who puts such a vile mixture into his land blame the system I am advocating for the miserable results he may obtain.

One Year's Ley.—For this purpose the varieties must obviously be restricted to those which yield a large and immediate return. Annual or Italian Rye Grass will form the basis of the mixture, and an addition of Perennial Rye Grass will generally be desirable, as also a very small quantity of Cocksfoot and of Timothy. For grazing, Broad Clover is preferable to Cow Grass, and White Clover will also be a necessary constituent. But for hay, Alsike should replace White Clover. Trefoil is a doubtful article; upon many soils it is indigenous, and in some few cases objectionable; but there are many instances where a proportion of it is not only legitimate, but necessary.

Two Years' Ley.—The extended duration of the ley justifies an increase of Timothy and Cocksfoot, but it is very easy to overdo the latter. Italian will almost certainly be preferable to Annual Rye Grass, but the proportion must be diminished, and a larger quantity of Perennial Rye Grass be substituted. Alsike and White Clover should be more freely sown, and the weight of Broad be slightly reduced. A heavier total seeding will be necessary to make a satisfactory two years' ley than is required for a single season, and more regard must be paid to peculiarities of soil and to the object in view.

Three Years' Ley.—Besides retaining Timothy, Alsike, White Clover, and Perennial Rye Grass, it is still necessary to include some Italian Rye Grass, Broad Clover, and Trefoil for the sake of the first year's produce. The value of the hay will be increased, and the pasture will be more palatable to stock, by partially replacing Cocksfoot with Meadow Fescue; and Foxtail must also be introduced. When the ley is needed for pasturage, an addition of Hard Fescue will render good service by making the bottom grass dense, and the Broad Clover may then be supplemented with Cow Grass. On chalky soils either Sainfoin or Lucerne may be desirable. The total quantity of seed will approximate more nearly to that required for a permanent pasture, although the finer varieties will be omitted.

Four, Six, or Eight Years' Temporary Pasture.—There is a general impression that, for so long a term as four years, a permanent prescription should be employed, but this is a mistake. Some of the finer grasses that are properly included for permanent pastures would be wasted if sown for only four years; they would scarcely become established until the term had nearly expired, and would certainly yield no adequate return for the outlay incurred. For the longer periods of six or eight years some modifications in the prescription must be made, but these will depend on the circumstances of each particular case. The

principal object is to ensure heavy crops, and this can only be done by an almost exclusive use of the stronger-growing grasses and clovers.

Temporary pastures are almost invariably sown with spring corn, and they require substantially the same treatment as permanent pastures, although, as the varieties are strong growers, there is not quite the same necessity for extreme caution in preparing the land; but even here laxity and carelessness entail a sufficiently heavy penalty.

A temporary pasture may, in a genial, showery summer, afford a valuable bite for horned stock soon after the corn is cut; and as the grasses are robust and comparatively coarse, although none the less nourishing on that account, they will not be injured by the hoofs of the cattle. The rolling should be done in November, instead of waiting until spring. Supposing stock to be kept off the ground, and the autumn to prove warm and genial, it will sometimes be possible by the end of October to get a cut of useful green food.

The pasture needs bush-harrowing and rolling down early in spring before being laid in for hay. The first year's crop will mainly consist of Rye Grasses and Clovers, but the bottom of a three or four years' ley may be expected to improve for at least two years, and the Foxtail, Timothy, Cocksfoot, Tall Oat Grass, and other plants, will increase in bulk in the third and fourth seasons.

A heavy dressing of cake-fed farm-yard manure applied towards the close of the year will pay well. Nothing improves artificial grasses so much, and there must be no niggardliness in its use. The fresher the manure when placed on the ground, and the less it has been allowed to ferment, the better the grass will thrive. In the Kidmore grass experiments good results were also obtained from a dressing of one hundredweight of nitrate of soda, with three-quarters of a hundredweight of muriate of potash, given in alternate years.

BOTANICAL DESCRIPTIONS, ANALYSES

AND

ILLUSTRATIONS

OF THE PRINCIPAL

GRASSES AND CLOVERS

USED IN

PERMANENT PASTURES

AND IN

ALTERNATE HUSBANDRY.

ALSO

ILLUSTRATIONS OF GRASS SEEDS.

NOTE by Dr. J. A. VOELCKER.

THE analyses in the following pages represent the chemical composition of the several grasses and clovers opposite which they appear. Each variety was grown separately and was perfectly pure; the sample being taken, in every instance, as nearly as possible at the time when it would have been cut for hay.

In these analyses for the first time the relative amounts of true albuminoids have been determined directly, and not, as in previously recorded results, merely given by calculation of the total nitrogen into albuminoids. It will be observed that in every case a very considerable proportion of the 'Total Nitrogen' exists in a non-albuminoid form, and that these proportions vary much in the individual grasses. It is not intended in these remarks to indicate more than the chemical features brought out by the analyses; for it must be apparent that chemical analysis alone cannot fully determine the relative values of different grasses and their suitability for permanent or other pastures. The adaptability of some kinds of grasses for certain soils, the amount of growth attained, the time of maturity, the length of duration, the ability to resist drought, the strength to overpower weeds, and other circumstances, must of necessity be taken into account. As far, however, as the chemical properties are concerned, the analyses show that the several grasses, cut just as they would have been for haying, have very different nutritive properties. These differences are most marked in respect of the water, the total nitrogen and albuminoid nitrogen, and in a somewhat lesser degree in the digestible fibre, soluble carbo-hydrates, &c.

The varying proportion of water in different grasses constitutes a point of much importance, for while the yield of two kinds may be equal in bulk, the nutritive properties of one may be far superior to those of the other. Not only must this be borne in mind when the grasses are used in the fresh or green state, as e.g. for ensilage, but also in considering them in the dried state, as hay, when, practically speaking, the value of the dry matter in each must be taken into account. For this reason the analyses of the grasses in the dried state, viz. at 212° Fahr., have also been given. If any special grasses are to be selected out of the number by reason of the high nutritive properties they possess, *Alopecurus pratensis*, *Festuca ovina*, *Poa nemoralis*, *Festuca heterophylla*, and *Poa trivialis* must be named among the first, and then *Lolium perenne*, *Phleum pratense*, *Anthoxanthum odoratum*, *Lolium italicum*, and *Dactylis glomerata*.

In the five first named, together with *Lolium perenne* and *Phleum pratense*, the amounts of total nitrogen and true albuminoids are considerably higher than in the other grasses. No one grass, taking the different nutritive properties together, excels, in a chemical sense (though others nearly approach), *Alopecurus pratensis*, which, besides being rich in flesh-forming constituents, contains also a high amount of digestible matters. While not being so highly nitrogenous in character as others named, *Anthoxanthum odoratum*, *Lolium italicum*, *Dactylis glomerata*, and *Avena flavescens* are specially rich in digestible carbo-hydrates, &c.

The clovers are marked by the high proportions of nitrogen and true albuminoids they contain, and by their small amounts of indigestible woody fibre as compared with the grasses. This may be best seen by a comparison of the analyses in the dried state, bearing out, as they do, the practical value of clover hay. Among the Clovers *Trifolium pratense* and *Trifolium hybridum* stand out prominently.

(Signed) J. AUGUSTUS VOELCKER.

NOTE AS TO THE COLOURED ILLUSTRATIONS.

THE coloured illustrations were drawn by Miss Butler expressly for this work, from specimens grown in soils naturally adapted to their full development. The plants were fine but not extravagant examples. As an instance, I may mention that near the Timothy, represented on Plate XIV., there was growing a very much larger head, which measured rather more than nine inches.

Each flower or portion of a plant is drawn to the exact natural size, but it has required care in some cases to bend the plant in such a manner as to bring the total length within the limited space of one of these pages.

MARTIN J. SUTTON.

AGROSTIS ALBA—VAR. STOLONIFERA.

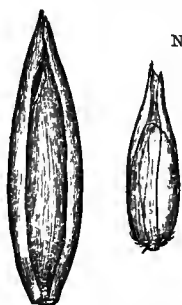
Fiorin, or Creeping Bent Grass.

AGROSTIS ALBA—VAR. STOLONIFERA.

FIORIN, OR CREEPING BENT GRASS.

Roots creeping, rootstock perennial and stoloniferous. Stems 6 inches to 3 feet. Leaves numerous, flat, and usually scabrid;

SEED OF
AGROSTIS ALBA—
VAR. STOLONIFERA.
(*Fiorin, or Creeping Bent Grass.*)



With and without the chaff.
Magnified 15 diameters.

Natural
size.

sheath rough; ligule long and acute. Panicle spreading, with whorled branches. Spikelets one-flowered, small. Empty glumes larger than flowering glumes, unequal, smooth, and awnless. Flowering glumes slightly hairy at the base, with occasionally a minute awn. Palea minute and cloven at the point. Flowers from July to September. Grows in pastures and damp places through-

out Europe, Siberia, North Africa, and North America.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	67.22	—
*Soluble albuminoids . . . . .	.06	.19
**Insoluble albuminoids	1.44	4.37
Digestible fibre	10.14	30.93
Woody fibre	13.30	40.57
†Soluble mineral matter	1.85	5.64
††Insoluble mineral matter . . . . .	.98	2.98
Chlorophyll, soluble carbo-hydrates, &c.	5.01	15.32
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.01	.03
** Containing Nitrogen . . . . .	.23	.70
Albuminoid Nitrogen . . . . .	.24	.73
Non-albuminoid Nitrogen . . . . .	.19	.58
Total Nitrogen	<u>.43</u>	<u>1.31</u>
† Containing Silica . . . . .	.17	.51
†† Containing Silica . . . . .	.60	1.83

ALOPECURUS PRATENSIS.

Meadow Foxtail.

ALOPECURUS PRATENSIS.

MEADOW FOXTAIL.

Roots fibrous, rootstock perennial. Stems 1 to 3 feet, erect and smooth. Leaves flat and broad; sheath smooth and longer than its leaf; ligule large and truncate. Panicle spike-like, cylindrical, and obtuse. Spikelets one-flowered, and laterally compressed. Empty glumes larger than flowering glumes, hairy on the keel, awnless. Flowering glumes with straight awn inserted at the middle of the back. Palea none. Flowers from the middle of April to June. Grows in meadows and pastures throughout Europe, North Africa, Siberia, and North-western India.

SEED OF
ALOPECURUS PRATENSIS.
(Meadow Foxtail.)



Magnified 10 diameters.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	55.58	—
*Soluble albuminoids . . . . .	.50	1.13
**Insoluble albuminoids	2.56	5.75
Digestible fibre	14.22	32.01
Woody fibre	16.42	36.96
†Soluble mineral matter	2.58	5.81
††Insoluble mineral matter . . . . .	.94	2.11
Chlorophyll, soluble carbo-hydrates, &c.	7.20	16.23
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.08	.18
** Containing Nitrogen . . . . .	.41	.92
Albuminoid Nitrogen . . . . .	.49	1.10
Non-albuminoid Nitrogen . . . . .	.30	.67
Total Nitrogen	<u>.79</u>	<u>1.77</u>
† Containing Silica . . . . .	.37	.83
†† Containing Silica . . . . .	.52	1.17

ANTHOXANTHUM ODORATUM.

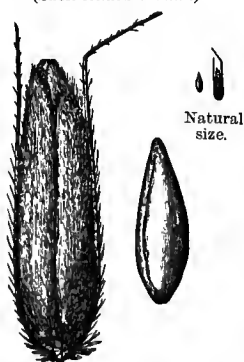
Sweet-scented Vernal.

ANTHOXANTHUM ODORATUM.

SWEET-SCENTED VERNAL.

Roots fibrous, rootstock perennial. Stems 1 to 2 feet, tufted, erect, glabrous, and with few joints. Leaves

SEED OF
ANTHOXANTHUM ODORATUM.
(Sweet-scented Vernal.)



With and without the chaff.
Magnified 12 diameters.

Natural
size.

hairy, flat and pointed; sheath ribbed and slightly hairy; ligule hairy. Panicle spike-like, pointed at summit, uneven below. Spikelets one-flowered, lanceolate. Empty glumes in two pairs; outer two much larger than the flowering glumes, unequal, hairy at the keels and pointed at the ends, awnless; second pair shorter and narrower than first pair, equal; also hairy and both awned, one with short straight awn inserted at the back near the summit, the other with long bent awn inserted at the centre of the back. Flowering glumes

small, glabrous, and awnless. Palea adherent to the seed. Stamens two. Anthers large. Flowers April and May. Grows in fields, woods, and on banks throughout Europe, Siberia, and North Africa.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	61.84	—
*Soluble albuminoids . . . . .	.69	1.81
**Insoluble albuminoids	1.31	3.44
Digestible fibre	14.43	37.81
Woody fibre	14.56	38.15
†Soluble mineral matter	1.76	4.61
††Insoluble mineral matter . . . . .	.83	2.18
Chlorophyll, soluble carbo-hydrates, &c.	4.58	12.00
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.11	.29
** Containing Nitrogen . . . . .	.21	.55
Albuminoid Nitrogen . . . . .	.32	.84
Non-albuminoid Nitrogen . . . . .	.20	.55
Total Nitrogen	<u>.52</u>	<u>1.39</u>
† Containing Silica . . . . .	.38	.99
†† Containing Silica . . . . .	.44	1.15



Gemell
University
Library

AVENA FLAVESCENS.

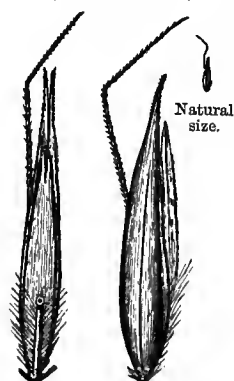
Yellow Oat Grass.

AVENA FLAVESCENS.

YELLOW OAT GRASS.

Rootstock perennial, creeping, and somewhat stoloniferous. Stems 1 to 2 feet, erect, glabrous, and striated. Leaves flat; sheath slightly hairy; ligule truncate and ciliated. Panicle spreading, with many branches, broad at the base and pointed at the summit. Spikelets three- or four-flowered, small, shining, and of a bright yellow colour. Empty glumes unequal, keeled, and rough. Flowering glumes hairy at the base and toothed at summit, with slender twisted awn springing from below the middle of the back. Palea narrow, short, and blunt. Flowers June, July, and August. Grows in pastures throughout Europe, North Africa, and Asia.

SEED OF
AVENA FLAVESCENS.
(Yellow Oat Grass.)



Front and side views magnified
8 diameters.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	63.11	—
Soluble albuminoids	—	—
*Insoluble albuminoids	1.50	4.06
Digestible fibre	11.95	32.39
Woody fibre	14.05	38.09
†Soluble mineral matter	1.04	2.81
††Insoluble mineral matter	1.11	3.01
Chlorophyll, soluble carbo-hydrates, &c.	7.24	19.64
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.24	.65
Non-albuminoid Nitrogen . . . . .	.14	.38
Total Nitrogen	<u>.38</u>	<u>1.03</u>
† Containing Silica13	.35
†† Containing Silica75	2.03



Gomell
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France

CYNOSURUS CRISTATUS.

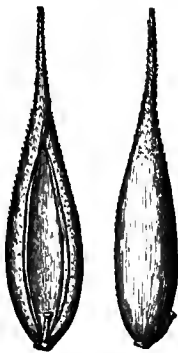
Crested Dogstail.

CYNOSURUS CRISTATUS.

CRESTED DOGSTAIL.

Rootstock perennial, stoloniferous. Stems 1 to 2 feet, tufted, erect, smooth, and wiry. Leaves

SEED OF
CYNOSURUS CRISTATUS.
(Crested Dogtail.)



Front and side views magnified
10 diameters.

Natural
size.

very narrow, ribbed, slightly hairy; sheath smooth; ligule short and bifid. Panicle spike-like, secund. Spikelets many-flowered, ovate, flat, with a barren spikelet consisting of empty glumes arranged in a pectinate manner at the base. Empty glumes sharply pointed, shorter than flowering glumes, unequal, with prominent rough keels. Flowering glumes lanceolate, with a short awn at summit. Palea very thin, slightly ciliated. Flowers July

and August. Grows in dry hilly pastures throughout Europe, Western Asia, and North Africa.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	72.33	—
Soluble albuminoids	—	—
*Insoluble albuminoids	1.50	5.38
Digestible fibre	7.91	28.59
Woody fibre	11.34	40.98
†Soluble mineral matter	2.08	7.51
††Insoluble mineral matter . . . . .	.76	2.74
Chlorophyll, soluble carbo-hydrates, &c.	4.08	14.80
	<u>100.00</u>	<u>100.00</u>
° Containing Nitrogen . . . . .	.24	.86
Non-albuminoid Nitrogen . . . . .	.18	.65
Total Nitrogen	<u>.42</u>	<u>1.51</u>
† Containing Silica . . . . .	.19	.68
†† Containing Silica . . . . .	.39	1.41



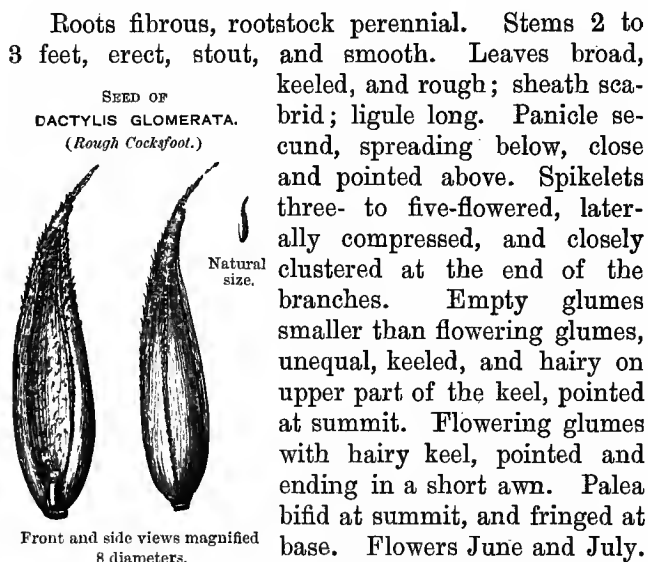
CYNOSURUS CRISTATUS.

DACTYLIS GLOMERATA.

Rough Cocksfoot.

DACTYLIS GLOMERATA.

ROUGH COCKSFOOT.



Roots fibrous, rootstock perennial. Stems 2 to 3 feet, erect, stout, and smooth. Leaves broad, keeled, and rough; sheath scabrid; ligule long. Panicle secund, spreading below, close and pointed above. Spikelets three- to five-flowered, laterally compressed, and closely clustered at the end of the branches. Empty glumes smaller than flowering glumes, unequal, keeled, and hairy on upper part of the keel, pointed at summit. Flowering glumes with hairy keel, pointed and ending in a short awn. Palea bifid at summit, and fringed at base. Flowers June and July.

Grows in pastures, woods, orchards, and waste places throughout Europe, North Africa, North India, and Siberia.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	60.74	—
*Soluble albuminoids . . . . .	.25	.62
**Insoluble albuminoids	1.50	3.81
Digestible fibre	11.30	28.78
Woody fibre	16.24	41.36
†Soluble mineral matter	2.04	5.19
††Insoluble mineral matter . . . . .	.91	2.32
Chlorophyll, soluble carbo-hydrates, &c.	7.02	17.92
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.04	.10
** Containing Nitrogen . . . . .	.24	.61
Albuminoid Nitrogen . . . . .	.28	.71
Non-albuminoid Nitrogen . . . . .	.18	.46
Total Nitrogen	<u>.46</u>	<u>1.17</u>
† Containing Silica . . . . .	.35	.89
†† Containing Silica . . . . .	.51	1.29

FESTUCA PRATENSIS.

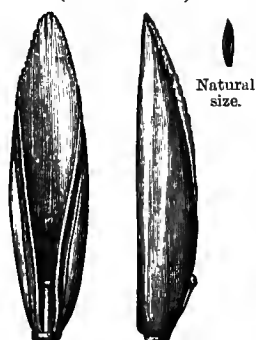
Meadow Fescue.

FESTUCA PRATENSIS.

MEADOW FESCUE.

Rootstock perennial. Stems 18 inches to 3 feet, tufted, erect, and smooth. Leaves flat and smooth;

SEED OF
FESTUCA PRATENSIS.
(Meadow Fescue.)



Front and side views magnified
7 diameters.

sheath smooth; ligule short. Panicle spreading, but closer and narrower than in *F. elatior*, with fewer branches. Spikelets many-flowered, lanceolate. Empty glumes shorter than flowering glumes, unequal and acute. Flowering glumes rough, and slightly awned. Palea acute and ribbed, with hairy nerves. Flowers June

and July. Grows on good pastures throughout Europe and Northern Asia.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	71.04	—
Soluble albuminoids	—	—
* Insoluble albuminoids	1.13	3.88
Digestible fibre	8.91	30.77
Woody fibre	12.51	43.19
Soluble mineral matter	1.05	3.62
† Insoluble mineral matter . . . . .	.64	2.21
Chlorophyll, soluble carbo-hydrates, &c.	4.72	16.33
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.18	.62
Non-albuminoid Nitrogen . . . . .	.18	.62
Total Nitrogen	<u>.36</u>	<u>1.24</u>
† Containing Silica . . . . .	.39	1.35

FESTUCA ELATIOR—VAR . FERTILIS.

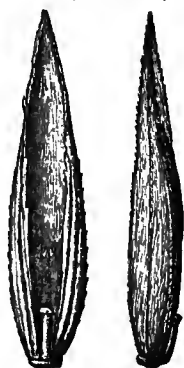
Tall Fescue.

FESTUCA ELATIOR—VAR. FERTILIS.

TALL FESCUE.

Rootstock perennial, somewhat stoloniferous. Stems 3 to 6 feet, erect and smooth. Leaves broad,

SEED OF
FESTUCA ELATIOR.
(*Tall Fescue.*)



Front and side views magnified
6 diameters.

Natural
size.

flat, and scaberulous; sheath smooth; ligule short. Panicle diffuse and nodding. Spikelets many-flowered, half an inch long or more, lanceolate. Empty glumes shorter than flowering glumes, acute and unequal. Flowering glumes broad, rough, and toothed at the apex. Palea acute and ribbed, with hairy nerves.

Flowers June and July. Grows in damp pastures and wet places throughout Europe, North Africa, and North America.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	71.25	—
Soluble albuminoids	—	—
* Insoluble albuminoids	1.31	4.50
Digestible fibre	6.80	23.65
Woody fibre	14.25	49.56
Soluble mineral matter	1.09	3.79
† Insoluble mineral matter . . . . .	.56	1.95
Chlorophyll, soluble carbo-hydrates, &c.	4.74	16.55
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.21	.72
Non-albuminoid Nitrogen . . . . .	.13	.45
Total Nitrogen	<u>.34</u>	<u>1.17</u>
† Containing Silica . . . . .	.31	1.08

FESTUCA HETEROPHYLLA.

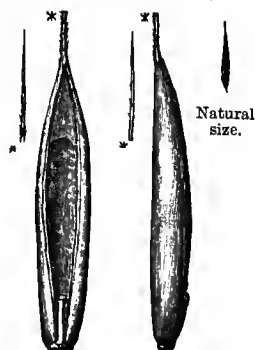
Various-leaved Fescue.

FESTUCA HETEROPHYLLA.

VARIOUS-LEAVED FESCUE.

Roots fibrous, rootstock perennial, tufted. Stems 2 to 2½ feet, numerous, erect, and smooth. Leaves

SEED OF
FESTUCA HETEROPHYLLA.
(Various-leaved Fescue.)



Front and side views magnified
6 diameters.

various, dark green, lower ones folded, triangular, upper ones flat. Ligule almost obsolete. Panicle diffuse. Spikelets many-flowered. Empty glumes unequal, shorter than flowering glumes, with prominent midrib and long awn. Flowers June and July. Grows in meadows and pastures throughout

Central Europe; introduced into Great Britain for cultivation in permanent pastures.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	41.07	—
*Soluble albuminoids	31	50
**Insoluble albuminoids	2.13	3.64
Digestible fibre	17.81	30.22
Woody fibre	26.21	44.48
†Soluble mineral matter	3.18	5.39
††Insoluble mineral matter	1.51	2.56
Chlorophyll, soluble carbo-hydrates, &c.	7.78	13.21
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.05	.08
** Containing Nitrogen . . . . .	.34	.58
	.39	.66
Non-albuminoid Nitrogen . . . . .	.42	.71
	.81	1.37
	<u>.81</u>	<u>1.37</u>
† Containing Silica . . . . .	.36	.61
†† Containing Silica . . . . .	.94	1.59

FESTUCA OVINA TENUIFOLIA.

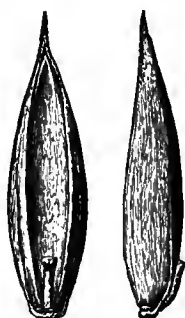
Fine-leaved Sheep's Fescue.

FESTUCA OVINA TENUIFOLIA.

FINE-LEAVED SHEEP'S FESCUE.

Rootstock perennial, tufted. Stems 6 to 12 inches, erect, and densely tufted, rough at the upper part

SEED OF
FESTUCA OVINA TENUIFOLIA.
(*Fine-leaved Sheep's Fescue.*)



Natural
size.

Front and side views magnified
15 diameters.

and smooth below. Leaves very slender, chiefly radical, upper ones rolled; sheath smooth; ligule long and bilobed. Panicle small, erect, contracted, and subsecund. Spikelets many-flowered, small, upright. Empty glumes shorter than flowering glumes, unequal and acute. Flowering glumes small, with minute awn. Palea toothed, with hairy nerves.

Flowers June and July. Grows in dry, hilly pastures throughout Europe, Siberia, North Africa, North America, and Australia.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	55.62	—
*Soluble albuminoids	1.06	2.44
**Insoluble albuminoids	1.54	3.37
Digestible fibre	16.72	37.77
Woody fibre	15.31	34.49
†Soluble mineral matter	1.59	3.60
††Insoluble mineral matter	1.72	3.88
Chlorophyll, soluble carbo-hydrates, &c.	6.44	14.45
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.17	.39
** Containing Nitrogen . . . . .	.24	.54
	Albuminoid Nitrogen	.41
Non-albuminoid Nitrogen . . . . .	.23	.54
	Total Nitrogen	<u>.64</u>
		<u>1.47</u>
† Containing Silica . . . . .	.69	1.58
†† Containing Silica	1.45	3.26



FESTUCA OVINA
FESTUCA

FESTUCA DURIUSCULA.

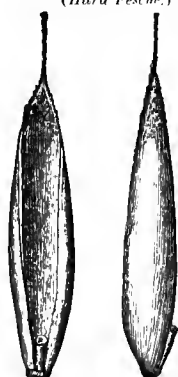
Hard Fescue.

FESTUCA DURIUSCULA.

HARD FESCUE.

Rootstock perennial, slightly creeping. Stems 1 to 2 feet, erect, and tufted, but less so than in *F. ovina*

SEED OF
FESTUCA DURIUSCULA.
(Hard Fescue.)



Front and side views magnified
10 diameters.

Natural
size.

tenuifolia. Stem-leaves flat, lanceolate, and striated; sheath downy; ligule long. Panicle erect and spreading when in flower. Spikelets many-flowered, and larger than in *F. ovina tenuifolia*. Empty glumes lanceolate and unequal. Flowering glumes narrow, with a short awn. Palea toothed, with hairy nerves. Flowers June and July. Grows in hilly places throughout Europe, North Africa, Siberia, North America, and Australia.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	61.98	—
*Soluble albuminoids . . . . .	.17	.44
**Insoluble albuminoids	1.50	3.94
Digestible fibre	6.53	17.18
Woody fibre	23.19	60.99
†Soluble mineral matter	1.52	4.01
††Insoluble mineral matter . . . . .	.86	2.26
Chlorophyll, soluble carbo-hydrates, &c.	4.25	11.18
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.03	.07
** Containing Nitrogen . . . . .	.24	.63
Albuminoid Nitrogen . . . . .	.27	.70
Non-albuminoid Nitrogen . . . . .	.11	.29
Total Nitrogen	<u>.38</u>	<u>.99</u>
† Containing Silica . . . . .	.38	.99
†† Containing Silica . . . . .	.47	1.34



Condit
L. K. Gray
L. H. H. H.

FESTUCA DURIUSCULA

LOLIUM PERENNE SUTTONI.

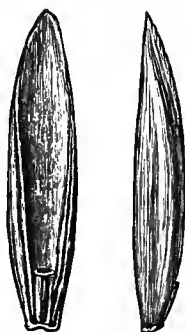
Sutton's Perennial Rye Grass.

LOLIUM PERENNE SUTTONI.

SUTTON'S PERENNIAL RYE GRASS.

Roots fibrous, rootstock perennial, sometimes stoloniferous. Stems 1 to 2 feet, bent at the base, ascending, smooth, and slightly

SEED OF
LOLIUM PERENNE SUTTONI.
(Sutton's Perennial Rye Grass.)



Front and side views magnified
8 diameters.



Natural
size.

compressed. Leaves flat, narrow, and obtuse; edges and upper surface scabrid; sheath smooth and compressed; ligule short and blunt. Panicles spiked. Spikelets many-flowered, solitary, sessile, distichous. Empty glumes, only an outer one to each spikelet, except in the case of the upper spikelet, which has two, lanceolate, smooth, distinctly ribbed, and shorter than the spikelets.

Flowering glumes obtuse, ribbed, and with sometimes a minute awn. Flowers May and June.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	62.01	—
*Soluble albuminoids . . . . .	.38	1.00
**Insoluble albuminoids	2.06	5.38
Digestible fibre	7.98	21.01
Woody fibre	17.71	46.62
†Soluble mineral matter	2.90	7.64
††Insoluble mineral matter . . . . .	.78	2.05
Chlorophyll, soluble carbo-hydrates, &c.	6.18	16.30
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.06	.16
** Containing Nitrogen . . . . .	.33	.86
	<u>.39</u>	<u>1.02</u>
Albuminoid Nitrogen	.38	1.00
Non-albuminoid Nitrogen		
	<u>.77</u>	<u>2.02</u>
Total Nitrogen		
† Containing Silica . . . . .	.05	.13
†† Containing Silica . . . . .	.32	.84



LOLIUM PERENNE SUTTONI

LOLIUM ITALICUM SUTTONI.

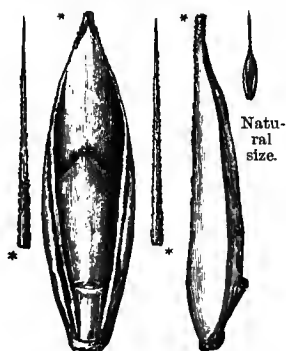
Sutton's Italian Rye Grass.

LOLIUM ITALICUM SUTTONI.

SUTTON'S ITALIAN RYE GRASS.

Annual or biennial. Root fibrous. Stems 2 to 4 feet, erect, stout, smooth. Leaves long, broad,

SEED OF
LOLIUM ITALICUM SUTTONI.
(Sutton's Italian Rye Grass.)



Front and side views magnified
7 diameters.

Natu-
ral
size.

glabrous, and succulent; sheaths slightly rough; ligule short and obtuse. Spikelets many-flowered, sessile, distichous on a long rachis. Upper empty glume only present in the terminal spikelet; lower empty glume persistent, lanceolate, obtuse, scarcely reaching to middle of spikelet. Flowering glumes lanceolate. Awn almost as long as glume.

Palea ciliate at base. Flowers June and July. Not known in a wild state.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	60.84	—
*Soluble albuminoids . . . . .	.25	.75
**Insoluble albuminoids	1.31	3.31
Digestible fibre	11.46	29.30
Woody fibre	11.09	28.32
†Soluble mineral matter.	1.35	3.47
††Insoluble mineral matter	1.10	2.81
Chlorophyll, soluble carbo-hydrates, &c.	12.60	32.04
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.04	.12
** Containing Nitrogen . . . . .	.21	.53
	Albuminoid Nitrogen	.25
Non-albuminoid Nitrogen . . . . .	.19	.50
	Total Nitrogen	<u>1.15</u>
† Containing Silica . . . . .	.24	.61
†† Containing Silica . . . . .	.91	2.33

PHLEUM PRATENSE.

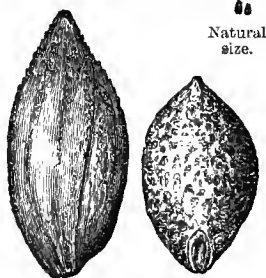
Timothy, or Meadow Catstail.

PHLEUM PRATENSE.

TIMOTHY, OR MEADOW CATSTAIL.

Rootstock perennial, somewhat creeping. Stems 1 to 3 feet, erect and smooth. Leaves short, flat, and soft; sheath smooth; ligule oblong. Panicle spike-like, cylindrical, elongate, and compact. Spikelets one-flowered, laterally compressed. Empty glumes larger than flowering glumes, equal, each with stiff hairs on the keel and a short scabrid terminal awn. Palea minute and pointed. Flowering glumes much smaller than empty glumes, toothed and awnless. Flowers end of June to August. Grows in meadows and pastures throughout Europe, North Africa, Siberia, and Western Asia.

SEED OF
PHLEUM PRATENSE.
(Timothy, or Meadow Catstail.)



With and without the chaff.
Magnified 15 diameters.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	39.99	—
*Soluble albuminoids . . . . .	.25	.43
**Insoluble albuminoids	2.19	3.63
Digestible fibre	12.74	21.23
Woody fibre	31.97	53.27
†Soluble mineral matter	3.59	5.98
††Insoluble mineral matter	1.26	2.09
Chlorophyll, soluble carbo-hydrates, &c.	8.01	13.37
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.04	.07
** Containing Nitrogen . . . . .	.35	.58
Non-albuminoid Nitrogen . . . . .	.39	.65
Albuminoid Nitrogen . . . . .	.48	.80
Total Nitrogen . . . . .	.87	1.45
† Containing Silica . . . . .	.27	.45
†† Containing Silica . . . . .	.69	1.16



PHLEUM PRATENSE.

POA PRATENSIS.

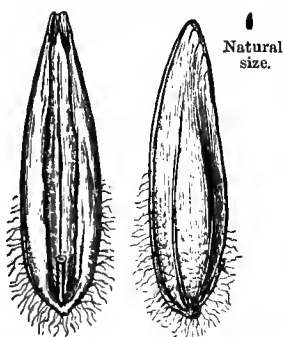
Smooth-stalked Meadow Grass.

POA PRATENSIS.

SMOOTH-STALKED MEADOW GRASS.

Rootstock perennial, creeping and stoloniferous. Stems 1 to 2 feet, erect, smooth, and rather stout.

SEED OF
POA PRATENSIS.
(Smooth-stalked Meadow Grass.)



Front and side views magnified
15 diameters.

Leaves flat, rather broad and slightly concave at the tip; sheath smooth and longer than its leaf; ligule short and blunt. Panicle loose, spreading and pyramidal in shape. Spikelets three-to-five-flowered, compressed. Empty glumes much webbed, lanceolate, almost equal. Flowering glumes larger, webbed, keeled, and acute. Palea short. Flowers June and early in July. Grows in mea-

dows and pastures throughout Europe, Siberia, North Africa, and North America.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	65.81	—
Soluble albuminoids	—	—
*Insoluble albuminoids	1.81	5.31
Digestible fibre	9.29	27.17
Woody fibre	15.24	44.57
†Soluble mineral matter	1.11	3.24
††Insoluble mineral matter	1.42	4.13
Chlorophyll, soluble carbo-hydrates, &c.	5.32	15.58
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.29	.85
Non-albuminoid Nitrogen . . . . .	.15	.44
Total Nitrogen	<u>.44</u>	<u>1.29</u>
† Containing Silica . . . . .	.40	1.17
†† Containing Silica	1.13	3.29



POA PRATENSIS.

POA TRIVIALIS.

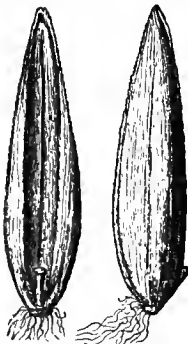
Rough-stalked Meadow Grass.

POA TRIVIALIS.

ROUGH-STALKED MEADOW GRASS.

Rootstock perennial, somewhat creeping, but not stoloniferous. Stems 1 to 2 feet, erect, rough and

SEED OF
POA TRIVIALIS
(Rough-stalked Meadow Grass.)



Natural
size.

Front and side views magnified
15 diameters.

slender. Leaves flat, narrow, acute, and rough; sheath rough and equal to its leaf; ligule long and pointed. Panicle loose, spreading and pyramidal in shape. Spikelets three- to five-flowered, compressed. Empty glumes webbed, lanceolate, and nearly equal. Flowering glumes keeled and acute. Palea short and slightly fringed. Flowers June to end of July.

Grows in meadows and pastures throughout Europe, Siberia, North Africa, and North America.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	42.50	—
*Soluble albuminoids . . . . .	.92	1.56
**Insoluble albuminoids	1.50	2.69
Digestible fibre	18.45	32.00
Woody fibre	20.31	35.32
†Soluble mineral matter	2.24	3.90
††Insoluble mineral matter	1.58	2.75
Chlorophyll, soluble carbo-hydrates, &c.	12.50	21.78
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.14	.25
** Containing Nitrogen . . . . .	.24	.43
	Albuminoid Nitrogen	.68
Non-albuminoid Nitrogen . . . . .	.13	.24
	Total Nitrogen	<u>.92</u>
† Containing Silica . . . . .	.15	.27
†† Containing Silica	1.40	2.44



POA TRIVIALIS

POA NEMORALIS SEMPERVIRENS.

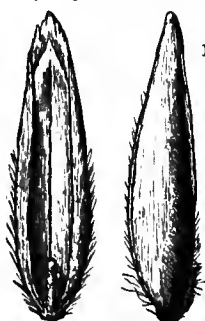
Evergreen Meadow Grass.

POA NEMORALIS SEMPERVIRENS.

EVERGREEN MEADOW GRASS.

Rootstock perennial, slightly creeping, but not stoloniferous. Stems 1 to 3 feet, erect, smooth.

SEED OF
POA NEMORALIS
SEMPERVIRENS.
(Evergreen Meadow Grass.)



Front and side views magnified
12 diameters.

Natural
size.

Leaves narrow, pointed, rough on the surface and outer edges ; sheath smooth ; ligule none or very minute. Panicle diffuse, slender, and nodding. Spikelets lanceolate, compressed. Empty glumes acute, nearly equal, sometimes slightly webbed. Flowering glumes rather larger, lanceolate, with three hairy ribs. Palea with nerves slightly fringed. Flowers June and

July. Grows in woods and shady places throughout Europe and Northern Asia.

ANALYSIS.

	Grass in Natural State.	Dried at 212° Fahr.
Water	35.92	—
*Soluble albuminoids	1.08	1.69
**Insoluble albuminoids	2.69	4.19
Digestible fibre	17.48	27.28
Woody fibre	27.65	43.15
†Soluble mineral matter	2.65	4.14
††Insoluble mineral matter	2.25	3.51
Chlorophyll, soluble carbo-hydrates, &c.	10.28	16.04
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.17	.27
** Containing Nitrogen . . . . .	.43	.67
	<u>.60</u>	<u>.94</u>
Non-albuminoid Nitrogen . . . . .	.26	.41
Albuminoid Nitrogen . . . . .	.86	1.35
Total Nitrogen	<u>.86</u>	<u>1.35</u>
† Containing Silica78	1.22
†† Containing Silica	1.73	2.72



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POA NEMORALI - SEMPERVIRENS.

TRIFOLIUM REPENS PERENNE.

Perennial White Clover.

TRIFOLIUM REPENS PERENNE.

PERENNIAL WHITE CLOVER.

Rootstock perennial. Stems solid, prostrate, creeping, rooting at the nodes. Stipules lanceolate-cuspidate. Leaves on long stalks. Leaflets obtuse or obcordate; margins finely toothed, generally with a white curved band. Peduncles axillary, long, erect, bearing a globose head of flowers. Pedicels deflexed after flowering. Calyx-teeth unequal, subulate, slightly shorter than tube. Corolla persistent, white or pink, turning brown. Pods three- to four-seeded. Flowers from May to October. Native of Europe, North Africa, Asia, India, and North America.

ANALYSIS.

	Clover in Natural State.	Dried at 213° Fahr.
Water	80.59	—
*Soluble albuminoids . . . . .	.36	1.88
**Insoluble albuminoids	1.44	7.56
Digestible fibre	4.83	24.71
Woody fibre	4.73	24.36
†Soluble mineral matter	1.59	8.20
††Insoluble mineral matter . . . . .	.81	4.21
Chlorophyll, soluble carbo-hydrates, &c.	5.65	29.08
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.058	.30
** Containing Nitrogen . . . . .	.23	1.21
Albuminoid Nitrogen . . . . .	.288	1.51
Non-albuminoid Nitrogen . . . . .	.29	1.51
Total Nitrogen	<u>.578</u>	<u>3.02</u>
† Containing Silica . . . . .	.13	.69
†† Containing Silica . . . . .	.30	1.56

TRIFOLIUM PRATENSE.

Red or Broad Clover.

TRIFOLIUM PRATENSE.

RED OR BROAD CLOVER.

Biennial. Root much branched, fibrous. Stems hollow, branching from base, clothed with fine hairs. Stipules membranous; free portion adpressed to stem, terminating abruptly in a bristle-like point; veins anastomosing. Leaflets oblong, obtuse, pubescent, usually strongly marked with a crescentic band. Heads terminal, sessile, globose. Flowers dull rose-purple. Calyx-teeth hairy, as long as tube. Corolla persistent, turning brown. Pods one-seeded. Flowers June to September. Grows throughout Europe, Central and Northern Asia, and India.

ANALYSIS.

	Clover in Natural State.	Dried at 212° Fahr.
Water	66.89	—
*Soluble albuminoids . . . . .	.62	1.94
**Insoluble albuminoids	2.94	8.87
Digestible fibre	5.70	17.22
Woody fibre	8.78	26.52
†Soluble mineral matter	2.58	7.80
††Insoluble mineral matter . . . . .	.67	2.02
Chlorophyll, soluble carbo-hydrates, &c.	11.82	35.63
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.10	.31
** Containing Nitrogen . . . . .	.47	1.42
Albuminoid Nitrogen . . . . .	.57	1.73
Non-albuminoid Nitrogen . . . . .	.26	.81
Total Nitrogen	<u>.83</u>	<u>2.54</u>
† Containing Silica . . . . .	.03	.10
†† Containing Silica . . . . .	.06	.19

TRIFOLIUM PRATENSE PERENNE.

Perennial Red Clover.

TRIFOLIUM PRATENSE PERENNE.

PERENNIAL RED CLOVER.

Perennial. Root long and tapering. Rootstock branching freely. Stems solid, erect or ascending, glabrous or sub-glabrous, tinged with purple. Stipules membranous, veined, gibbous at the base, free portion longer than in *T. pratense*, and more or less purple. Leaflets elliptical or oblong-lanceolate, broadly marked. Heads terminal and axillary, sessile or slightly stalked, ovoid. Flowers deep purple. Calyx-tube sub-glabrous, teeth setaceous, unequal, pods one-seeded. Flowers July.

ANALYSIS.

	Clover in Natural State.	Dried at 212° Fahr.
Water	70.24	—
*Soluble albuminoids . . . . .	.56	2.00
**Insoluble albuminoids	2.31	7.81
Digestible fibre	7.66	25.68
Woody fibre	8.52	28.63
Soluble mineral matter	1.94	6.52
†Insoluble mineral matter . . . . .	.60	2.03
Chlorophyll, soluble carbo-hydrates, &c.	8.17	27.33
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.09	.32
** Containing Nitrogen . . . . .	.37	1.25
Albuminoid Nitrogen . . . . .	.46	1.57
Non-albuminoid Nitrogen . . . . .	.16	.54
Total Nitrogen	<u>.62</u>	<u>2.11</u>
† Containing Silica . . . . .	.06	.23



TRIFOLIUM PRATENSE PERENNE

TRIFOLIUM HYBRIDUM.

Alsike Clover.

TRIFOLIUM HYBRIDUM.

ALSIKE CLOVER.

Rootstock perennial. Stems hollow, branched, flexuous, glabrous. Stipules ovate-lanceolate, veins few. Leaflets obovate or elliptical, denticulate. Peduncles axillary, longer than the leaves. Heads globose, depressed. Calyx glabrous, teeth equalling tube. Corolla persistent, white or pink, turning brown. Pods three- to four-seeded. Flowers July and August. Native of Europe, North Africa, and Western Asia.

ANALYSIS.

	Clover in Natural State.	Dried at 212° Fahr.
Water	70.78	—
*Soluble albuminoids	1.06	3.69
**Insoluble albuminoids	2.00	6.81
Digestible fibre	5.34	18.30
Woody fibre	8.49	29.05
†Soluble mineral matter	1.90	6.49
††Insoluble mineral matter . . . . .	.74	2.55
Chlorophyll, soluble carbo-hydrates, &c.	9.69	33.11
	<u>100.00</u>	<u>100.00</u>
• Containing Nitrogen . . . . .	.17	.59
•• Containing Nitrogen . . . . .	.32	1.09
Albuminoid Nitrogen . . . . .	.49	1.68
Non-albuminoid Nitrogen . . . . .	.35	1.21
Total Nitrogen	<u>.84</u>	<u>2.89</u>
† Containing Silica . . . . .	.01	.03
†† Containing Silica . . . . .	.07	.26



MEDICAGO LUPULINA.

Common Yellow Clover, or Trefoil.

MEDICAGO LUPULINA.

COMMON YELLOW CLOVER, OR TREFOIL.

Annual, or biennial. Stems much branched from base, hairy or sub-glabrous. Leaflets obovate, denticulate, emarginate, mucronate. Stipules obliquely ovate-toothed. Peduncle longer than the leaf. Head many-flowered, depressed, ovoid. Flowers lemon-yellow. Pedicels shorter than calyx; calyx-teeth longer than tube. Standard of corolla longer than wings. Pods naked, black, one-seeded. Flowers May to August or September. Distributed throughout Europe, North Africa, and India.

ANALYSIS.

	Clover in Natural State.	Dried at 212° Fahr.
Water	71.47	—
*Soluble albuminoids . . . . .	.42	1.50
**Insoluble albuminoids	1.81	6.50
Digestible fibre	6.10	21.22
Woody fibre	7.85	27.51
†Soluble mineral matter	2.05	7.19
††Insoluble mineral matter	1.25	4.39
Chlorophyll, soluble carbo-hydrates, &c.	9.05	31.69
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.069	.24
** Containing Nitrogen . . . . .	.29	1.04
Albuminoid Nitrogen . . . . .	.359	1.28
Non-albuminoid Nitrogen . . . . .	.38	1.35
Total Nitrogen	<u>.739</u>	<u>2.63</u>
† Containing Silica . . . . .	.20	.70
†† Containing Silica . . . . .	.57	2.01

ACHILLEA MILLEFOLIUM.

Yarrow, or Milfoil.

ACHILLEA MILLEFOLIUM.

YARROW, OR MILFOIL.

Rootstock perennial, creeping extensively underground, with smooth reddish stolons. Stems 2 to 3 feet, erect, furrowed, woolly or sub-glabrous. Stem-leaves lanceolate; radical leaves stalked, both doubly pinnatifid; lobes cut into linear segments. Heads corymbose, dense. Phyllodes oblong, obtuse, glabrous. Flowers white or pink. Ray flowers few. Ligule broad as long. Disc flowers perfect, five-toothed. Fruit oblong, compressed, shining. Flowers June to September. Native of Northern Europe, Northern and Western Asia, Northern India, and North America.

ANALYSIS.

	Yarrow in Natural State.	Dried at 212° Fahr.
Water	78.01	—
*Soluble albuminoids . . . . .	.05	.25
**Insoluble albuminoids	1.37	6.19
Digestible fibre	6.82	31.04
Woody fibre	6.49	29.51
Soluble mineral matter	1.33	6.04
†Insoluble mineral matter . . . . .	.98	4.47
Chlorophyll, soluble carbo-hydrates, &c.	4.95	22.50
	<u>100.00</u>	<u>100.00</u>
* Containing Nitrogen . . . . .	.008	.04
** Containing Nitrogen . . . . .	.22	.99
Albaminoid Nitrogen . . . . .	.228	1.03
Non-albaminoid Nitrogen16	.75
Total Nitrogen	<u>.388</u>	<u>1.78</u>
† Containing Silica38	1.73

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